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to Virtualization

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VIRTUALIZATION

CHAPTERS

VIRTUALIZATION
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Introduction

What you're reading is printed on paper, but was originally written on a computer inside a word processor. So what's real? The paper in your hands or the original document in which it was created? Absurd question, yes but then there are questions which when pondered over can bend the perceptions of reality. Leaving philosophies where they belong, the point we're trying to make here is that virtualization is a similar concept and definitely something you want to try your hands at, if you've not already. Once you get a hang of it, you'll keep returning to it. How can we be so sure, you ask?

None of us is completely satisfied with our computers. There's always something lacking for the enthusiasts. A Windows user might just want an awesome environment that Linux offers with all the free and powerful goodies, a Linux user might miss the might of Microsoft Word and a Mac user might want a break away from fancy GUI by trying out something else. No matter what your needs – be it software development, configuration testing, office document creation, software use on only one particular OS or just testing what's new in an overhyped OS (read Windows 8) – virtualization is for you. It allows you to install new operating system(s) on the same machine without worrying about hard disk formats or the risk of destroying things.

Virtualization is a world in itself and powers many of the new and upcoming technologies. Right from allowing you to scan for safety against viruses to cloud computing, it's expanding everywhere. New tools are being made and careers are being born. Virtualization is a silent revolution and you can be a part of it. What you're holding in your hand is a 5 X 7.5-inch window to an exciting world which may just rock your perception of what a desktop is! **d**

WHAT IS VIRTUALIZATION?

Introducing the technology and concept of a world of machines within a machine

Virtualization or Virtual Machines are a way of emulating hardware in software. If that sentence was a little tricky to understand, try this – using virtualization you can run an operating system on top of another. If you've not used any virtualization software yet, you're definitely missing out on something. Virtualization is achieved with the help of software. This software is a program which allows you to install a new operating system while not utilising the available hardware directly. We're sure this might still sound a little messy if you're completely new to virtualization. Wait till we show you the methods and how it's done!

How does it work?

So, how exactly does an operating system run on top of another? After all,

an operating system itself runs programs and it can't just run another set of programs which manage the computer (another operating system). As we've already mentioned, this is done using virtualization software.

Virtualization software is a program which can fool an operating system into believing that it is utilising the computer's hardware which isn't the case. The software actually creates an environment wherein it emulates the various hardware components of the computer. When one tries to launch (or install) an operating system, the virtualization software will inform the operating system being run about the hardware that it emulated rather than about the actual hardware installed on the computer. This technique is called "sandboxing".

The operating system is run inside a sandbox (or a virtual environment) which looks real but isn't. When creating a new Virtual Machine, you need to tell the virtualization software some information such as:

▶ The amount of RAM you want to allocate to that operating system: This amount of memory is reserved by the software from the real RAM on the system.

▶ The number of cores you want to allot the operating system: Some virtualization software allow you to allot more than the actual

☠ CAUTION

☠ Since the amount you allot for the hard disk is allocated inside a file (which will be kept on your real system), you're limited by the free space available on the partition where you're saving the virtual hard disk file. So if you're trying to allocate 20 GB of hard disk space to the virtual machine and you only have 10 GB of space on the partition where the virtual hard disk file will be saved, this space will fall short and either the hard disk wouldn't be created, or if it gets created, you'll run into problems like slow operation or crashes. Remember that in such situations, the behavior would depend on the nature of your virtualization software. When the space gets filled up, one thing is sure – your real system (the one where the virtualization software is installed) will begin to crawl. Moreover, (as we already said) depending on the virtualization software you're using, the virtual machine may crash and your whole system might hang or crash. So ensure you have enough free space on your hard disk to create the amount of space you want the virtual machine to have.

number of cores available on the machine. That too is done by emulating the extra cores.

▶ The hard disk size the virtual machine will have access to: Assuming you allot 20 GB of hard disk space to the virtual machine, you can think of this as "attaching a hard disk whose full size capacity is 20 GB". Usually the size is allocated on your machine as a file and you can decide the interface. Since everything in there is virtual, you can also create more than one hard disk (unlike partitions on a real hard disk, you would be actually emulating more than one hard disk).

▶ The number of network adapters the virtual machine will have and their configuration which determine factors such as:

- Will the machine be isolated?
- Will it be using a Network Address Translation (NAT) mechanism to allow the internet access to the virtual machine?
- Will it be an internal network which can be used only within the various virtual machines running on that virtualization software?
- Should the Network Adapter appear as if the cable has been disconnected?
- What should be the MAC address of the network adapter(s)?
- What type of network adapter it would be?

Depending on the virtualization software, a few more options are provided to help you customise the networking behavior of the operating system running within.

▶ The number of removable devices you'll have in your system.

▶ Should it be an ISO file which looks like a DVD drive to the machine or should the machine have access to your real drives?

▶ Should the virtual machine be able to access your USB drives?

▶ Whether the virtual machine can play audio in the real system.

There are still a few more options which can be configured for every virtual machine you create using the virtualization software. We'll look into that later as we discuss the various software available for the purpose and their features.

Depending on the options you've selected for the virtual machine, the virtualization software will decide what hardware to emulate and how to emulate. A small diagram would help you understand how it all works.

Role of hardware features

Although virtualization is all about fooling an operating system about the
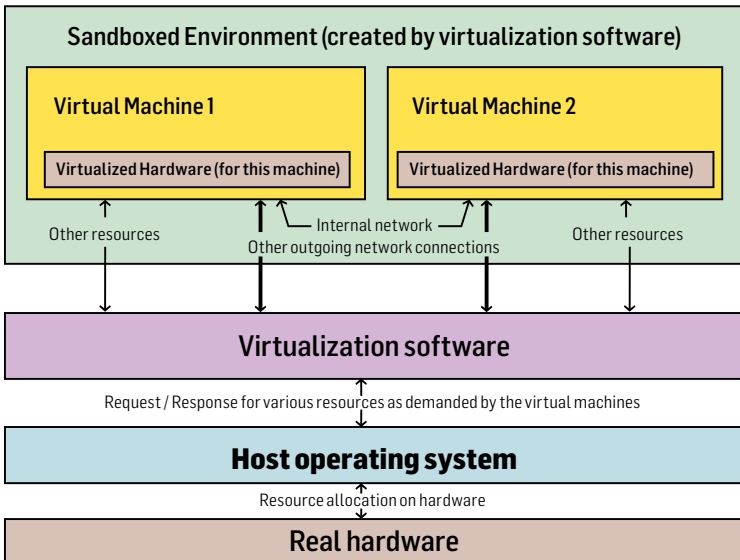
Figure 1: How virtualization works

hardware being real, it most certainly depends on the hardware that's actually installed on the computer. Without a powerful computer, virtualization can be a big pain.

When virtualization gets an OS running over the top of another, the bigger picture has the following things happening inside:

▶ The real (or the HOST) operating system is running and managing a few applications and services.
▶ One of those applications and services is the virtualization software.
▶ Virtualization software is running another (or may be more than just one) operating system (the GUEST operating system).
▶ The Guest operating system is thinking that it's running on a computer which it is not!
▶ There are probably some applications being run on the guest operating system that are trying to put some load on the hardware as well.
▶ All the load being created by the Guest operating system is being sent to the real hardware via the Host operating system.

Processor

You can clearly tell that there are a bunch of operations going on. All these

operations are going to require a decent amount of processor power. So if you have a processor which isn't fast, virtualization will make you feel the pain even more so. At times, you may encounter freezes of the Host operating system. Now, when we say a processor that's "powerful enough", we're not simply meaning the "clock frequency". So if your neighbor has a dual core Core-i3 processor which runs at 1.87 GHz per core and you have an Atom processor which runs at the same speed, your performance is going to be low. If there's a resounding "why" in your mind, you should know that the performance of the processor not only depends on the clock frequency but also on a couple of other major factors namely the "Supported Instruction Set" and "Cache Size". Since a processor belonging to "Atom" line won't be having as much Cache as a processor belonging to the Core-i3 line, Atom would go slow.

Hardware restriction such as "heat-dissipation" is another factor for the performance bottleneck (which indirectly means that a desktop computer with average cooling is going to be better than a laptop with the same specifications (well, yes the processors would vary in the "model" but the "specs" can be the same). You're probably convinced by now that virtualization is going to require a decent amount of processing power, although it doesn't demand a high performance rig either. A laptop would work just as well for virtualization as long as you take care of cooling.

For those who are familiar with the OS architecture (engineering students, eh?) you probably know about the ring structure of the operating system wherein the core system functionality is actually run on the processor in a "privileged" mode while the rest is running in a "non-privileged" mode. In case of virtualization, wherein you're trying to emulate a "processor", it's necessary that the processor is emulated well. This emulation requires massive processor power when the virtualization software is trying to emulate the "privileged" and "non-privileged" modes of the processor to the guest operating system. The reasons are obvious – the virtualization software itself runs in "user" mode or "non-privileged" mode. When the guest operating system issues a hardware request (such as a "disk read"), it has to emulate such events and they must look like a "privileged mode" operation to the guest. Hence, overall, the scene is such: a "non-privileged" process trying to execute "privileged" code. Such emulation is really costly on the processor and takes up plenty of processing power as the virtualization software tries to switch to and from the "privileged" and "non-privileged" modes for the guest while asking the host operating system for resources.

To help make virtualization easy, Intel and AMD have developed hardware features which aid in virtualization, namely VT-x and AMD-V by each company. Depending on the make of your processor, if it supports one of these features, virtualization will be smoother and faster. However, this doesn't mean that it will fail otherwise. Along with this, it's better to have a processor with more than one core. While almost every processor has more than one core today, the old ones (up to Pentium 4) didn't have this. While we've seen virtual machines running on a Pentium 4 as well, the performance wasn't all that great.

RAM

When Microsoft says that Windows 7 requires at least 512 MB of RAM for a decent performance, it's obvious that you can't expect good performance when you use Windows 7 as a guest operating system inside Windows Vista (as the host) when you have only 1 GB of RAM. Why? We all know that Vista is a memory hog. It struggles to survive with 1.5 GB of RAM and the performance is really poor. Above that, if you start Windows 7 as a guest, it would take up another 512 MB leaving Vista with only 1 GB and a lot of overhead which will come from the Windows 7 running inside some virtualization software. It's just like trying to run Photoshop's latest version with that much of RAM. While some would say that "Photoshop would run decently", they should know that virtualization software isn't like Photoshop or any other application program because an application program can be fully managed by the operating system. On the other hand, virtualization software run operating systems which demand for hardware more than any application software. If you try to manage the virtual machine on a system with low amount of memory, the virtual machine can get dead slow if you cross the limits of your RAM. The real (host) operating system would try to manage the memory and page out a few things to the disk and then, everything starts getting slower! It's wise to remember that OSes running inside the virtual machine act stubborn and can freeze the machine. The reason for their stubborn behavior is quite simple. The guest OS thinks (well, it can't literally "think" but it's given an environment which makes it believe it can) that all hardware is real while couldn't be further from the truth. The guest operating system tries to take control more rigorously while the virtualization software tries to map the requests of the guest onto the host operating system. All this makes the scene complex. So, always remember to have enough RAM before you launch the virtual machine. In case, you

don't have too much of RAM and the demands of the guest operating system are quite high, don't allocate too much of memory to the guest operating system. This will make the guest run slow but keeps the host operating system in good shape ensuring that the computer doesn't crash or freeze, losing all your data in the process if things go haywire.

Processor and RAM are the two most important factors effecting performance in virtualization. We've already spoken about hard disk space so we'll not get into that again. Just remember to allocate enough space for the guest operating system. If you're low on hard disk space, try to stick to the recommended minimum amount for the guest OS you plan to install. If you allocate a really low amount of space to the OS, things will fail anyway; if not, well, we don't really need to repeat the words "low performance" all the time, do we?

The Guest and the Host

Till now we've been talking about the guest operating system and the host operating system. In case these terms still confuse you, remember that they mean the same thing in virtualization terminology as they do in the real world.

A guest is someone who is temporary, someone who comes, goes and maybe returns. He's not a permanent member of your home. You don't allow him access to everything you have in your home but still you want him to feel comfortable. This is similar to the operating system running inside virtual machine software (virtualization software) wherein you can switch on and switch off the virtual machine. You don't allocate all the resources to the virtual machine but still try to allocate enough to make it run smoothly. This signifies the word "guest" being used for the operating system being run inside a virtualization software.

The host is someone to whom the place belongs, one who welcomes and manages different guests. He's someone more authoritative and permanent in nature, someone who manages the whole show. He's someone who was there and will be there even if there are no guests. This nature signifies the real operating system installed on the system and hence, we use the word "host" for the operating system really installed on the machine. It's the operating system where you install the virtualization software itself.

Try to remember this terminology well and don't confuse them. In case you go ahead with virtualization, install virtualization software and guest operating systems inside them and fall into problems and want some help

from the internet, confusion between these terms will leave you in a whole lot of mess and you'll only make things worse.

Uses in the world today

While virtualization is fun to play with, there are a lot of more uses than just testing little applications and trying out operating systems for fun. There are a lot of other uses which are not known to the general users as such. One of those is the great wor(l)d of cloud computing.

Cloud computing, is a way to make use of more than one computer to serve one purpose. This "one purpose" may consists of many other tasks and the "purpose" itself is to provide the software as service. When we say "software as a service" (or SAAS, as many would call it), we actually mean – a way of allowing the user to use the software without him allowing to install the software on his machine. One good way of understanding it is a "website". Although not "truly" a SAAS, a website allows you to store your data on it and process it, search for it or utilize it for other things, but it does not need you to install any servers on your machine. Taking "Facebook" as an example, it allows you to upload your pictures, organize them and use them for getting comments and likes from your friends but it does not ask you to install the software it uses to facilitate all that.

Normally a small website such as a Blog would be able to run on a single machine which has the database, the web server and other components installed on it but when the data gets too large, it has to be distributed across many, many machines. Taking "Facebook" again as an example, it hosts more than 100 billion pictures. There is no way you could keep all of that on a single machine. In such cases the pictures are to be distributed across many machines connected to each other via a network. As the amount of data increases, it becomes cumbersome to manage all the data. With new machines being added all the time into the network with different (and improved) features and capabilities, the scene gets even messier.

Virtualization in such cases serves more than one purpose. A virtual environment allows the service provider to virtualize the storage and put the same software across all the machines without trouble. It increases the security and manageability of the whole system and with advanced virtualization software, interoperability of the machines, fault detection, dynamic resource allocation and load balancing can be done more easily. All that helps you visualize a system with large amounts of memory and storage available to you without hassles. It helps manage the network and other resources.

Also, do notice and remember that Virtualization helps a lot in cloud computing scenario but is not a mandatory part of it. So it is possible to create a cloud computing platform which does not depend on Virtualization. Such a system may not be as manageable as one using advanced Virtualization tools but would, by no means be deficient of features. All of this, certainly depends a lot on how the network of computers are managed and availed as a "service" or "infrastructure".

We know all that might sound a bit complicated in the beginning with a whole lot of IT Administration terms thrown in and it is in fact, complicated. What we just wanted to point out is the role virtualization can play in cloud computing.

What does Virtualization look like?

Virtual machines may sound intimidating but is not as tough as one might think it is. There are a lot of software package available for a general user to try out the virtual machines. Some of them are quite famous, some are not. Some are free, some are not. Some are cross plat form, some are not. With a whole lot of options, you might just pick up the one which interests you and your wallet and get going.

Testing a new operating system cannot be easier than with a virtual machine. Remember one thing though – if you want to test your real hardware being compatible with an operating system, virtualization is the step you do NOT want to take.
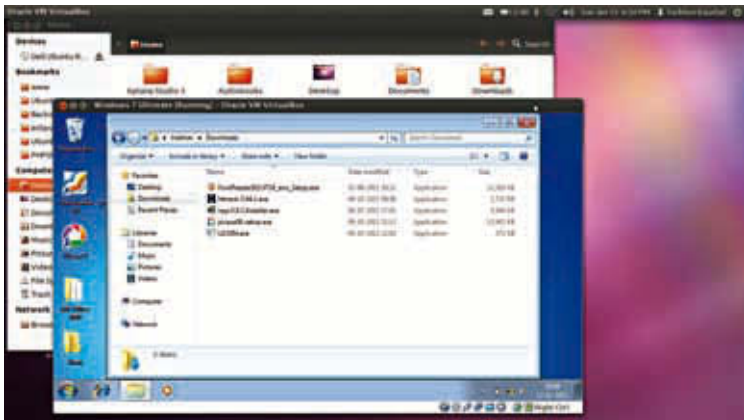
Figure 2: Windows 7 running inside an Ubuntu as a virtual machine using VirtualBox

You see above is a Windows 7 machine is virtual machine running inside VirtualBox on Ubuntu. Here, Ubuntu is the Host, Windows 7 is the Guest and VirtualBox is the virtualization software in use. Virtualization is not so difficult and is available easily for your desktop. There is quite a list of software available for it and that is the thing we are going to talk in some time. But before we continue, we would tell you what all virtualization software can do for you and what you should look for in them. That should guide you with the selection later as we discuss the list as well as when you download a new one from the internet.

Remote Connection

Desktop Virtualization Server

Windows XP
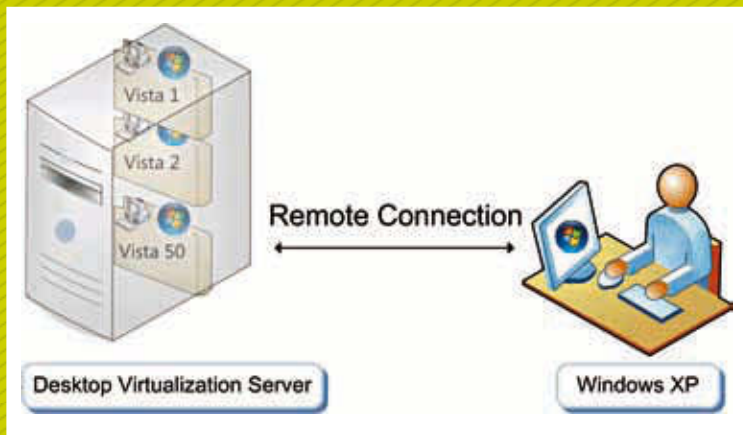
VIRTUALIZATION IN THE REAL WORLD

In this chapter, you'll read about real world uses for virtualisation

Virtualization on servers

Virtualization as we said is the art of making an operating system run atop another. It's especially beneficial for use on servers depending on who you are. If you're just a regular user, you'd give two hoots about it. On the other hand, if you're a developer or someone who deals with IT technologies, you would know the importance more than the general crowd.

Virtualization on servers allows maximum resource usage and cuts down on cost required to run multiple servers. Let's say you're in need of a setup wherein you have to run quite a few machines, each doing a specific job such as one machine running the database, another running the web

server, a third hosting the FTP server and yet another handling the emailing job and so on. At such a point in time, the following come into the picture:

▸ Purchasing as many machines as you require. This is going to get costly.

▸ Setting them up, connecting them to the network and installing software on them. If you're going to make two or more servers do the same job (such as two servers being used as a database server at one time), you're going to have to repeat the same task on both of them.

▸ Administering and maintaining them individually.

▸ Providing the extra electricity, networking facility and floor space (the space the server will occupy in the real world – think of it as the space you need to place your desktop's CPU cabinet in your room).

All of this might seem inevitable but with virtualization, it becomes a lot less complicated than it would be without it. With virtualization, the scene becomes something like this:

▸ You can create multiple virtual machines on the same server, thus saving on the cost of buying new machines. Also, you're making optimum use of one machine which is a good thing!

▸ Since you can set up a single virtual machine and then clone it to get the same setup again, setting up multiple servers repetitively becomes a thing of past – you're now in need of doing copy-paste rather than

Virtualbox dynamic guest processor frequency adjustment

reconfiguration. This saves time, and adding new machines is much faster and easier.

▸ Advanced virtualization software for servers come with inbuilt monitoring and maintenance features, which not only save plenty of money and time but also lots of manual effort (and that's the best part).

▸ Since you're using only one server for running many machines (virtual machines), you don't need more electricity and floor space either. Notice that we just compared the scene with and without virtualization. There are other benefits which virtualization provides; a few follow:

▸ **Upgrading gets easier:** Upgrading software on servers is a tough task. Sometimes you just need to shut down the machine and when it's about servers which make a business run, it's not always possible. With virtualization, you can simply clone the machine and upgrade it and then replace it with the current one. Well, it's not so easy as it seems but comparatively it's a lot easier. Again, if you need to restart a machine, all you have to do is power off the virtual machine and bring it back on! So much easier compared to restarting the real machines (with virtualization, the restarting job can be done remotely).

▸ **Scalability:** It simply means the ability to expand. So if today you're happy with one server, tomorrow the business will grow and you'll need two servers, and then three and then probably even more! Virtualization makes scaling a whole lot easier. Let's consider a scenario: you have one server which runs seven virtual machines each doing its own job and one of them is a machine that handles email. Now suppose lots of email starts coming in and you're in need of sending a bunch of mail as well (imagine Facebook – it sends a huge number of emails per second for all those likes, shares and comments). That's when you're in need of another email server. You can easily create a clone of the first email server virtual machine and use it to create another one on a different server and configure the setup! Now if you want to move the email server virtual machine to another physical server, you can easily do that; after all, you just need to copy a virtual machine!

▸ **Saving software costs:** If you have to install more servers which will run more than one virtual machine, virtualization will help save money. How? Let's suppose, you have five physical servers with Windows Server as the host OS on them; they run multiple VMs on each of them and are fully loaded. If you need to create more virtual machines, you'll need a sixth physical server. Now, if you were to install Windows Server on the sixth machine as well, it would cost you quite a lot. But you don't need to spend! The guest OS (the one running inside the virtualization software) never knows that it's not running on the real hardware. So you can just install Linux on the sixth server and then create the virtual machines inside it and it will work just as well!

▸ **Resource sharing:** As mentioned before, if you wanted to create a new email server with a virtual machine, you could just create a copy of the first virtual machine running the email server and it would work fine. However, both email servers need to share the database where the emails

are stored! If both of them run separately, they'll have their own (virtual) disks and won't work, right? Yes, they won't work but only if you forget that the disks that those virtual machines will use are also virtual. With good virtualization software, you can mount remote disks. So the second email server might just be able to use the first email server's disks as well! There can be different types of configurations by which this can be done, so much so that they're beyond the scope of this little book. It's just to make the point that the resources used by virtual machines are also virtual and they can be used in various ways and one of those ways is to share the resources.

▸ **Recovery:** Let's say an administrator just made a mistake and accidentally made some changes to the machine configuration and now he and the other users are unable to find out what the change was! This can be a disaster without virtualization. Depending on what went wrong, what was destroyed and how important it was, virtual machines can help ease your troubles. Here are some examples:

- If you have a 'misconfiguration' issue and have cloned virtual machines then you can simply copy back the configuration!
- If it was data and you didn't have backups, but do keep regular snap shots, the virtual machine will reduce the heat you're going to take!
- If you have backed up or cloned disks, you don't really need to worry, do you?
- If the data which the virtual machine was working on was on a separate virtual disk than on which the OS of the virtual machine was installed, you can simply create a new one! (well, there are other complications but they're usually fewer than when you were not using virtual machines).

▸ **Fault-tolerance:** There are times when machines fail. They're meant to fail at some point in time! Virtualization can even help in such instances. Since all the hardware in use by the virtual machine is also virtual and can have multiple copies and at remote places, one server failing might not just bring down everything if you had other copies ready and running!

If you see now, it would be so very clear why virtualization is really good for servers. Because of these benefits, virtualization is slowly becoming the need for servers rather than a feature. One of the biggest things that virtualization brings to the world is cloud computing. While cloud computing doesn't really depend on virtualization, it does help in numerous ways.

Virtualization and cloud computing

Before we get into the technical aspects, it's important to understand what cloud computing is actually. In fact there are many terms you come across when trying to understand the concept; such as the Internet, Grid Computing, Clusters and Cloud.

▶ Internet is the network of all networks connected around the world and consists of the user machines (such as your very own laptop or tablet or desktop). So no need to be confused with 'cloud' here. When people talk about internet and cloud in the same line, they're talking about cloud computing setups publicly available on the internet, nothing more, nothing less.

▶ Cluster is a group of computers loosely connected in a way that they can be viewed as a single system. The term is mainly used in connection with the term "Distributed Computing". Remember that what we said is about the Computing Cluster. There is another term "Data Cluster" which has a different meaning altogether.

▶ Grid is a term given to computers (in terms of computing resources) which are used to accomplish a common goal. Do note that a Grid can be run atop a cluster or multiple clusters and can also use resources external to those clusters.

▶ Cloud is a set of networked or interconnected computers which are used to provide various services. A cloud can be actually a Grid or a Cluster or a hybrid setup of a different breed. Cloud as such has an ambiguous definition because everyone perceives it in a different way and that's because it can be used in as many multiple ways.

There are a few characteristics required as such which are essential to make a networked setup of computers be called a cloud. The key features of the cloud are:

- **On-Demand:** Cloud is the set of computers which provides its services on demand, which means that the cloud can be asked for more computational resources at one time or another!

- **Self-Management:** For a computer setup to be collectively called a cloud, it should be as free from manual intervention as possible. In case of a hardware or software failure, the computers themselves should be able to figure out a way to correct the mistake and retain the services they provide.

- **Broad network access:** This is not really a different feature than a cluster or Grid, depending on how you see it. It just states that the
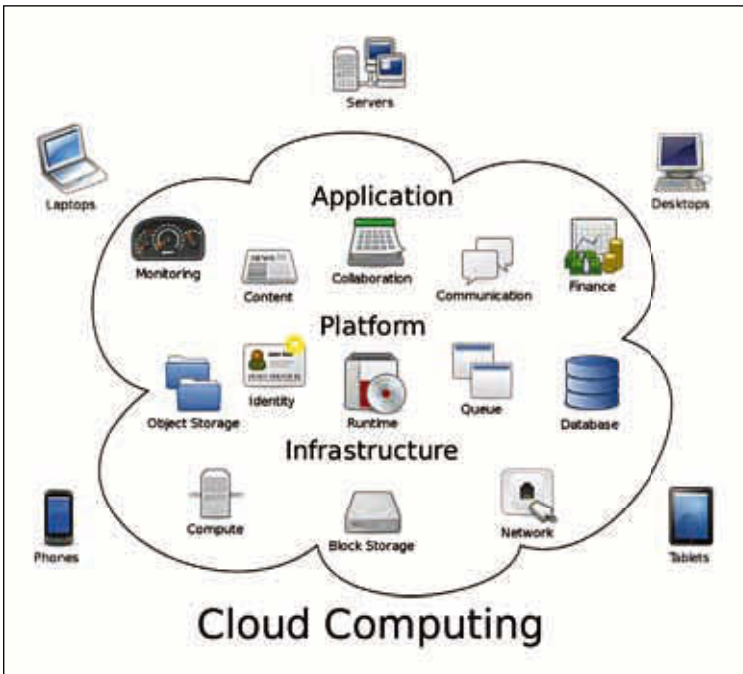
Cloud computing

cloud should be reachable from different areas and using different methods (this depends on whether the cloud is a public or a private cloud and the services it provides).

- **Resource Pooling:** You can view this feature as a subset of the On-Demand feature. It states that the computation resources available should be available as a large pool of resources off which any amount can be asked for at any time! It's this feature which actually brings the On-Demand characteristic.

If you were to read more literature related to the terms we just mentioned (Grid and Cluster), you'll find similar features are present in those as well! The main point of the 'Cloud' is service. A cloud offers services but it's not goal-oriented – so the person or organisation using it can use it the way they want to. While one might want to put lots of processing load on it, another person (or organisation) might want to use the storage service. The cloud is a setup which is ready to offer its services to anyone who wants to use it in the way he wants it.

So how does virtualization help here? Well, before actually answering the question, we need to look at the service models of a cloud. A cloud basically offers itself as one of the three:

▶ **Infrastructure as a service (IaaS):** This consists of the hardware and networking services such as computers, firewalls, routers etc.

▶ **Platform as a service (PaaS):** This consists of the infrastructure plus the platform. Here the platform refers to the operating system, programming language execution environment, software servers such as *FTP, HTTP,* email servers etc. A cloud offering a LAMP stack can be thought of as a PaaS cloud.

▶ **Software as a Service (SaaS):** This includes the infrastructure, platform and the software running on top. For example, a cloud with a blogging platform can be visualized as a SaaS cloud. Blogpost.com can be thought of as a SaaS because you don't have to care about what hardware, networking devices, programming languages or databases are in use behind the scene. You just have to use the software therein!

Virtualization can help in accomplishing the required actions easily for all the three models:

● Since all the hardware is virtual, you can have many virtual machines on many physical servers and that will form the backbone of a computational resource pool. Since all virtual machines can be managed with the virtualization software, maintenance and monitoring of resources becomes easier.

● Storage devices are virtual as well. Virtualization can help automate the creation of new disk drives on the fly and that can help expand everything! Also, all those storage devices can be managed with the virtualization software, hence making the "on-demand" and "resource pooling" characteristics of the cloud come near reality!

● Since networking between virtual machines is also handled by virtualization software, you can add and configure new network interfaces manually or automatically. Once again, a lot of ease! By points mentioned till now, we can say that virtualization can help IaaS model clouds!

● Installation of operating systems inside virtual machines can be automated. Also, with snapshot and cloning features, creation of new virtual machines can easily be accomplished. A pre-configured VM can be cloned and kept aside and can then be repeatedly used to create new virtual machines on the fly. On-demand, eh? Since all the components

of the platform part of a PaaS style cloud can be installed on the guest operating system, PaaS clouds are easier made with virtualization!

- Since SaaS clouds have just the top layer applications added to the operating system, those too can be installed on a virtual machine OS and once again cloning can make all those come near complete automation. So SaaS style clouds can also benefit greatly from virtualization.
- Along with this, self-management can also be achieved to a large extent by just tuning the virtualization software to the specific needs or using a particularly clever one.

As you can see, all this can be done without virtualization technology, but that would be a much more complicated scene than it is with virtualization in the picture!

Types of virtualization

There are different types of virtualization. Let's briefly explore each of them.

Full virtualization

This is the form in which everything is virtualized. By everything, we mean all the hardware components visible to the guest OS, which includes the processor, storage, networking components, display etc. Most desktop solutions available for virtualization such as VirtualBox, VMware Workstation, QEMU, Parallels Workstation etc. are "Full Virtualization" solutions. They can make any guest OS run atop any host OS as long as both are supported and you don't have to worry about a thing with them.

OS level virtualization

This is a little trickier than others. In this case, a full virtual machine is not run inside a virtualization software but the application(s) is (are). For those who know, this technique is like an advanced version of the chroot command in Linux (and other UNIX-like) OS wherein the application is given an environment to work and the application is made to believe that it is (and other related components) the only thing running on the system. This is done by isolation in something called as the "user-space" environment. The best example of this is the "jailed" environment in FreeBSD. Read more about the FreeBSD jail: *http://en.wikipedia.org/wiki/FreeBSD_jail*

Paravirtualization

It's not possible to fully describe in the small space here what it means.

However to give a brief idea, we'd say, it's something like "semi-virtualized" hardware case for the guest OS. In this type, a "hypervisor" is present which can make a "modified" guest OS work on the hardware. It helps improve speed to a substantial degree by allowing few things to be done directly on the hardware rather than implementing full sandbox. For example, if you have a x86 processor on the machine and you're also running a guest OS which can run on the same processor, most hardware can be allowed to be accessed directly (with some restrictions, of course), such as there is no need to emulate the processor as the instructions executed by the guest are okay for the processor to be executed directly. So the hypervisor sees that requests for doing calculations need not be sandboxed or emulated and hence can allow direct access of the processor. This saves the time it takes to emulate the actions and the processing remains fast. Remember however that it does need two mandatory things. Firstly, the guest OS kernel must implement a set of functions which make use of the hypervisor's assistance and that means the guest OS should be modified for the specific case. Secondly, virtualization assistant technologies (e.g. VT-x or AMD-V) should be present in the host machine processor. The "Xen hypervisor" is the best example here.

Advantages of virtualization

We've already discussed this at length, but to summarize, virtualization brings to you various goodies such as: ease of use, scalability for large deployments, failover and fault-tolerance on a system-wide level. It helps ease maintenance and monitoring of the machines and saves cost by hiding the implementation details from the virtual machines. For a general user, it brings an opportunity to experience new and different operating systems, allowing him/her to experiment with the different OSes.

Security

Virtualization mixed with security is a tricky matter as one has to take care of the security of two operating systems, one inside the other. For a general user, it's just okay to secure the host machine. The security scene for Grid, Cluster or Cloud setups with multiple servers is a different scenario and complicated enough. We won't go into that in this Fast Track. However, for a desktop user, it's essential to remember one thing: if you know that either the guest or the host is infected with a virus, make sure that you disconnect the virtual networking interface of the guest OS using the virtualization

software, scan the infected system and then re-enable the interface. Viruses (which come with worms usually) travel mainly via the network and just like the OS, they have no way of knowing whether the network is real or virtual.

Performance impact

Virtualization depends on emulation and sandboxing and when that's done, we're consuming the processor power for doing non-productive work. Most virtualization software available today make the virtual machine work reasonably fast and there are no grave performance issues, specially with processors with virtualization assisting technologies (which almost all processors since 2006 have). However, the one thing which can seriously impact performance is low available memory. With each virtual machine running, more and more memory (RAM) is required. If RAM is inadequate, performance can do down drastically. Also, if the work being done is intensive on the storage media, one must ensure that different virtual machines access different disks at the same time. Apart from that, processor scheduling is taken care of by the guest and the host operating system well enough and you should worry only if all the virtual machines run processor-intensive tasks at the same time and you didn't allocate the number of cores for each virtual machine wisely. **d**
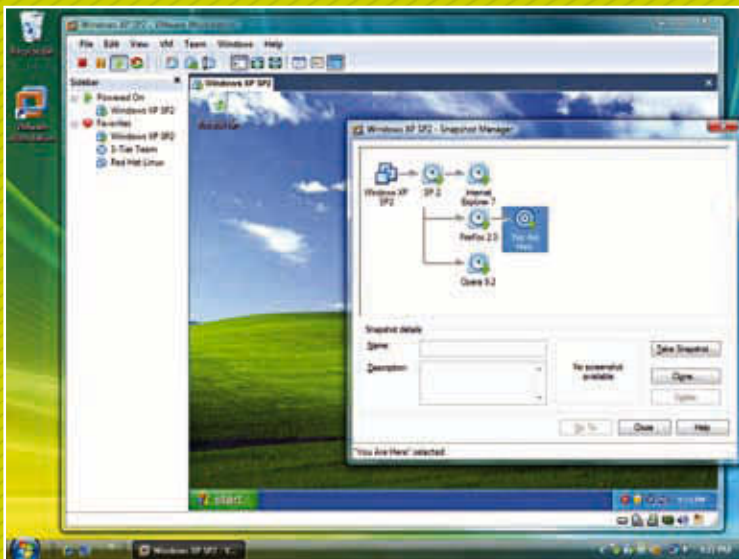
VIRTUALIZATION SOFTWARE – FEATURES TO LOOK FOR

We help you find the best software for your needs

Good software is often defined by its capabilities, its ease of use and stability. Virtualization software is no exception. Uses differ for the software from user to user. While one may use Windows only for gaming and another only for running MS

Word, there may be someone who wants to do both of them and a little bit of systems and web programming, some animation, a little server stuff and more. Lists are endless for the demands and there are software for which its manufacturers cry out loud "my product can do everything". Well, while having a lot is never bad if you need it all, it can certainly be bad if it turns out to be like the birthday gift you never wanted. You'll probably lose your mind trying to figure out what to do with it and go mental in the process. That's what extra features can do. They can cause instability, bloat your memory and slow down your system while running. We'll tell you the different features general virtualization software would / should have and the uses of those features. This will help you make decisions later on. What kind of decisions? Let's say you want to run multiple virtual machines at a time to learn networking and want virtualization software which is stable, consumes less memory and has different networking features for virtual machines. In such a case, you're not really in need of software which supports 3D effects and bloats your system unnecessarily.

Ability to take advantage of hardware features

In Chapter 2, we've already spoken about hardware features which assist in virtualization. One of them was the processor, which needs to have virtualization support. In the current line of processors, that means Intel VT-x and AMD-V. If the processor allows you to do things at a faster rate with more reliability and the software can't take advantage of it, then the fault is of the software.

Good virtualization software takes advantages of such hardware features. As a matter of fact, most popular ones do. Buy or download one that doesn't blow a hole in your pocket. Oh, and yes, in case you don't go in for Intel VT-X or AMD-V, you must also know whether your processor features those technologies or not. If your software supports them and the processor doesn't, it's once again a bad deal. In most cases, a software which supports virtualization features built into the modern processors would run on one which doesn't but there are exceptions. The biggest and most famous known such exception is the "XEN Hypervisor" – it doesn't work unless you have a processor featuring virtualization assistive technologies.

So yeah, make sure that your hardware and software both have support for it. If you have the hardware support, go for software which utilises it. It's a win-win situation.

Stability

What good would software be if it crashes when you push a button on its window? If it's not stable enough to make you run the virtual machines the way you want it to, by all means avoid it and go for another version of the same software or another software altogether. Let's say you're running a Linux system and a virtual machine crashes when you try to take snapshots in VirtualBox (a famous virtualization software). In such cases it's better to install KVM/Qemu than try to destroy things by running VirtualBox. Of course, we're not saying by any means that VirtualBox is bad software. This is just an example and Qemu could crash too. It's simply a matter of selecting a stable software.

Speaking of stability and VirtualBox in the same line, there's something you should know. VirtualBox can throw up quite a few errors just because you didn't install and configure it properly. This can happen with other software as well, but VirtualBox does this a lot more than others. Having incorrectly configured software is different than having an unstable one. Software that's not configured well will most likely give problems before you start running a virtual machine on it; whereas unstable software would crash and close itself after you've started working. So be prudent and scour the net for reviews before you start thinking that the software you're trying to use is an unstable one. Finding such things beforehand always helps.

Lower resource usage

Remember Windows Vista being a pathetic memory hog and the complaints that were shot at Microsoft for releasing it premature? Compare it to Windows 7. What was different if you look at the features? Hardly anything, but Windows 7 consumes a whole lot less memory and processor power than Vista did. Virtualization software consuming more memory would leave lesser headroom for the actual virtual machine you want to run. If you don't have too much RAM and one hell of a powerful processor on your system, it won't matter. The extra resource usage by the virtualization software will leave a lot lesser room for the actual virtual machine and things will begin to get slow!

Because we used Windows 7 and Windows Vista as examples, it doesn't mean that you have to wait for two years if the software you're trying to use consumes more memory than what you'd like it to. It's just that you should pick up the one which does the jobs you want it to and keeps it easy on your system.

Good support for virtual hardware in use

Virtualization software would emulate the hardware. If it emulates something which the guest operating system you want to install can't recognize or utilise, it becomes useless to try emulating such hardware. In most cases any and all hardware right from the processor and disks to network and display adapters are generally recognizable by most guest operating systems. However, if you're trying to run a Legacy operating system such as Windows 98 while emulating a SATA disk or a dual core processor, you'll land in trouble.

Virtualization software you're trying to run the guest OS on should be able to emulate various types of hardware interfaces and features. This should accommodate the latest technologies as well as older hardware interfaces. Of course, this depends on your usage. So if you're not going to run Windows 98 or the original Linux kernel written by Linus back in early 90's, worry not, most virtualization software can get your job done. Also, some virtualization software come with support for 3D and 2D acceleration. All this will help you get better response from the guest OS.

Networking facilities

Do you want to browse the internet within your guest OS? Or would you try to create two virtual machines and want to run a port scan on the first one from the second one? There are plenty of possibilities with networks. You might want to test how a computer behaves over the network. You might even want to develop a program and test whether it can communicate over the network. You could possibly want to learn the ninja techniques of networking and so on. That sounds good but may not work as well as you expect, if you have poor virtualization software which doesn't give you too many options.

Depending on the software in use, you just may be able to emulate an ethernet connection or wireless network connection. You would be allowed to emulate various networking interface types on different virtual network adapters, try out NAT (use this option, if available, to be able to browse internet on your guest OS), internal adapters, a bridging adapter and so on. Depending on your requirements, go ahead and select the best one. If you're simply trying to be able to browse the net within the virtual machine, most virtualization software can facilitate that.

Guest operating system support

Windows is different from Linux. BSD is not Linux either. Windows XP

and Windows 7 also behave differently. Windows 98 would be an alien to all the ones mentioned till now. Different operating systems behave differently and have varying hardware requirements. Although virtualization software just emulates the hardware, telling it the operating system you're going to use is a Guest will still help you. It helps the software determine the "recommended" resource allocation to be done such as hard disk space, memory to be allocated, amount of video memory, hardware accelerations and so on.

The virtual machine software (virtualization software) would give better performance when you tell it about the guest OS than if you don't. For example, while Windows depends on Registry heavily, Linux depends on configuration files. Both serve the same purpose but the frequency and speed with which the access is required is different. Also the file systems in use by them would differ. Most virtualization software let you know the type and version of OS you're trying to use inside it. Also, the performance would be slightly higher if you provided the right information.

Another point to consider is the 64-bit support for the guest operating systems. While in most cases you'll be able to run a 32-bit guest operating system on a 64-bit host machine, it's not easy to do this when the situation is reversed. There's no way you can ask a 32-bit processor to work in a 64-bit mode. While some virtualization software support this request, some only support it experimentally and others don't support it at all! Lack of support for such features can easily take a toll on your performance or stability. You might encounter freezes, corrupted drivers, hangs and screens of death. Take care of such issues and investigate and search well on the internet before you actually try them out.

Snapshots

Just like a picture demonstrates the environment or the scene the way it was when you clicked it, a snapshot of a virtual machine is a way to demonstrate the machine's state the way it was when you took it. It's one of the most useful features for those who love to experiment. A snapshot in terms of a virtual machine is the way to save a virtual machine's state.

When you take the snapshot, the virtualization software actually freezes the virtual hard disk file and the configuration of the machine at the time you took it. It also ensures that whatever you do after that point doesn't modify the files. What it rather does is create new files which it uses to save the new changes made and the changes you make in the configuration of the

machine. When we say the files were "frozen", it actually means that it was made sure that those files weren't altered. Later on, you can use the feature in the virtualization software you're using to revert back to that snapshot.

When you revert back to a snapshot you took earlier, you get the machine as it was when you took the snapshot. If you had a file on the guest operating system when you took that snapshot, but deleted it after taking the snapshot, the file would be restored. The settings would be as you left them and the virtual machine would behave as if it was never changed at all. This is because the virtual hard disk files were frozen when the snapshot was taken.

NOTE

Don't confuse this feature with "cloning" which actually creates a new virtual machine with the same state as the virtual machine you're cloning from. When you "clone" a virtual machine, you actually create a new virtual machine which may (depending on the features of the virtualization software in use) use the same disk files and configuration of the present machine or have its own set of disk and configuration files which make it behave just as the virtual machine you're cloning. It may be a clone of only a particular "state" (we're talking about the state determined by the "snapshots" you've taken for the machine) or have all the states. The difference between snapshot and cloning is that cloning creates a new virtual machine with possibly new virtual hard disks and configurations while snapshots just freeze the current machine and create new files to store the changes you're going to make to the current machine. You might think that cloning too is just like taking a snapshot – after all, you can create multiple clones of the same machine at the times you want; but that's not the truth. There are two main differences. First, a clone will take up more space on your computer because the disk files are recreated or copied. Secondly, you can't create a clone of a virtual machine while that machine is running. Although cloning is a feature, there's a reason we don't mention it as a feature you should look for in virtualization software. To create a new virtual machine in the current state, you simply need to copy its virtual hard disk files (and possibly some configuration files which are created in the same folder / directory as the virtual hard disk), paste it somewhere else and create a new virtual machine utilising those files. There, you now have a clone! You can then remove the snapshots in the copied machine to make it come to whatever state you want it to.

Depending on the virtualization software you're using, you can create multiple snapshots at various points. You'll then be able to return to any of these moments, effectively making you feel like you've gone back in time. You can also use snapshots for creating a single virtual machine and configuring it for various purposes, each in one snapshot of its own. It can also be used for tracking your progress at multiple stages by creating a new snapshot at every new stage so that you could revert back to a previous stage if you needed to undo something you did but don't remember what it was.

Snapshots can save you lots of time and quite a lot of work as well. Let's take an example: Let's suppose you want to install Ubuntu Linux for doing web development works. Now you don't want to install a new operating system, so you decide to install a virtualization software for the purpose. You happen to select VirtualBox for the same. Now, you install the latest version of Ubuntu inside VirtualBox, as a virtual machine (a VM, for short). You take a snapshot at this point to ensure that you don't have to install the operating system again. You name this snapshot as "Installed Ubuntu". Next, you install all the required software on it to prepare the operating system for your development works. You test everything and find that things are working well! You take another snapshot at this point and name it as "Ready for Web Development" and save it so that you don't have to install web development software like the web server, the IDE and the database later on, even if something goes wrong. You make a few pages and are satisfied that things are working fine. So you take another snapshot and call it "Started developing". The very next day you find that a new version of the database you're using has been released. With excitement, you perform the update and find that things aren't working well.

What do you do in a moment like this? You have a few options:

1. Create a new virtual machine, install Ubuntu Linux on it again, then download and install the software required for web development.
2. Revert to the "Installed Ubuntu" snapshot where Ubuntu was installed but the required software wasn't. Then you can download and install the software again.
3. Revert to "Ready for Web Development" snapshot where Ubuntu and the required software for your work was installed inside the virtual machine. You only have to continue the development work from scratch.
4. Revert to the "Started developing" snapshot where the operating system and the required software were installed and you had also created some web pages after some elbow grease.

Which one would you prefer? Most certainly the last one: reverting back to the "Started developing" snapshot, because that saves you the most effort! You get the operating system, the installed software and some of your work as well.

To get the most benefits out of snapshots, take a snapshot as soon as you've made precious changes to the virtual machine that you don't want to lose. This way you'll have many states and you'll have plenty of freedom to choose the state of the machine you want to go back to. In case you think that you don't require so many of them, you can delete the extra states you don't want to go back to (some virtualization software may also call this process "merging"). This will help manage things better so that you don't get baffled by so many snapshots. In the situation we talked about above, you might just want to remove the "Installed Ubuntu" snapshot because that way you're saving some space as well as getting the virtual machine in the state it's most required to be. If you're using the machine for web development, you would anyway want to have the software installed on it.

Since snapshots would create new files which only contain changes from another snapshot, they don't take too much disk space either. So you can be sure that if you create a few kilobytes of files in the virtual machines, you're not losing another 20 GB from your hard disk space; because the whole hard disk file is not recreated.

Snapshots are one really great feature to look for in virtualization software if you plan to use virtual machines which require you to make many changes in the guest operating system while ensuring that you're able to go
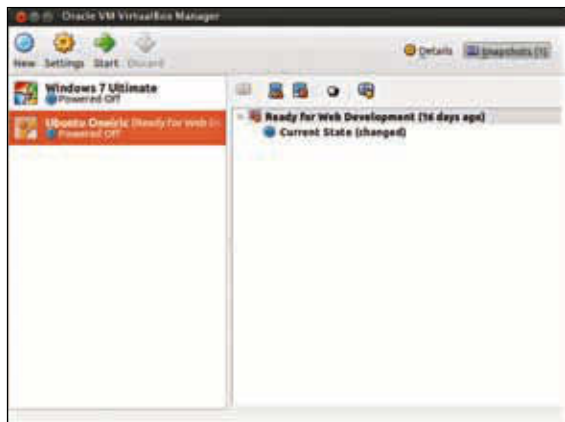
Figure 3: A Ubuntu Virtual Machine showing the current snapshots

back in time to a state where things were fine. It would typically involve software development and testing various applications and operating systems.

Remote accessibility

This one feature may not mean a lot to most people who plan to use virtual machines on their home computers for fun and experimentation. It may, however, be immensely useful to those who want to use VMs for remotely working on their computers. For example, if you have multiple computers at home and want to work with a virtual machine installed on your desktop PC from inside the coziness of a blanket on your laptop, this feature is for you. It may also be a great way to control the VM installed on your home PC from your office or vice versa.

Though the remote access feature is majorly useful for work, it could also be a life-saver even if you're using it for experimentation. Say, you need an important file such as a passport photo copy for some urgent government work. Though most popular virtualization software today have this feature, it's best to understand the risks you're up against when using it. Anyone is allowed to access your virtual machines unless you have some mechanism to protect access.

Guest add-ons – tools and drivers

Guest add-ons or tools are a set of drivers actually provided by the virtualization software for ease of use of virtual machines. This typically involves the display driver acting as a key component. They also facilitate better network operations inside the virtual machine, faster responses to input, faster processing, etc. Unless the software has these add-ons, don't expect a very pleasant experience. One of the biggest lags would be with the display, which
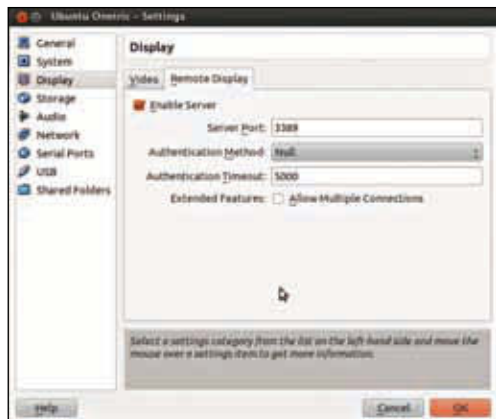
Figure 4: Remote display options in VirtualBox

would be slower. In some cases when the virtualization software supports 3D acceleration to a huge extent (VMware Workstation is the best example), not being able to install the guest tools or add-ons is going to limit your experience quite a lot. Not only would you be unable to run any graphical software inside the VM, the overall experience would also be affected. Sometimes, these add-ons are also required to play audio inside your guest operating system.

Before downloading the virtualization software of your choice, ensure that both your guest as well as host operating systems are well supported by the software in terms of the guest add-ons.

Ease of use and shared folders

Shared folders are one of the most important features if you want to create files inside your guest machine and then copy them to your host operating system. Shared folders are usually dependent on correctly installed guest add-ons.

"Shared folders" is a feature which allows you to map a folder on your host operating system as a network drive (in case of a Windows guest operating system) or a mounted network directory (in case of a Linux guest operating system) in the guest operating system.

Without this feature, you'll have to rely on another USB drive which you'd connect to first copy files from the guest operating system to the USB drive and then unplug the drive and reconnect to copy files to the host operating system. This is a cumbersome process for two reasons:

1. You need to have the USB drive accessibility inside the guest OS, which in turn depends on the virtualization software.
2. The VM might make the USB drive unavailable to your host OS and attach it to one or more machines running as guests. In such a situation, you'd have to copy the file first, then shut down the guest OS, unplug the device and then reconnect it to copy files onto your host OS. Now that's what we can call the difficult way of doing things!

Before you go on with choosing the software of your choice for creating virtual machines, ensure that you have the shared folders feature to help you ease such operations.

Another factor which ensures ease of use is the display system. This too heavily depends on the guest add-ons. If they're not installed correctly, you might just be locked down to a maximum resolution of 1024x768 pixels inside the VM which is quite low for productive uses. Also, auto-capture

of mouse pointer makes the job easy. The "mouse auto-capture" feature makes sure that when you have more than one application window running on the host and the VM window is one of them, the VM is able to use the mouse pointer as and when you hover over the window and leave the pointer when you pull the mouse pointer out of its boundaries. It allows you to be fast when you're working with a guest machine as well as a few other applications open on your system.

Another feature which eases up the work flow is a "bi-directional" clipboard. With an intuitive name, it allows you to do a [Ctrl +C] on your host OS to copy some text and paste it into your guest OS and vice versa. At times, it also allows you to copy files from the guest machine to the host and vice versa. If this is present, you might start feeling that the shared folders feature is an unnecessary one (although it has more uses than the obvious copy-paste operations).

When you're into virtualization, you'd want to have all of this at hand. Virtual machines are more than just for play and can be used for quite productive uses. When you're in need of a feature within a virtual environment and you don't have it, you start feeling locked in. Options would be limited and you may just start pulling out your hair in clumps. The best way to avoid such situations is to plan ahead – about your choice of OS inside the VM, applications you're going to run within and the kind of load they'll put on your machine, the networking and file-sharing features and so on. We hope you're well informed by now about the features you need to look for. When we discuss a triplet of great software available for the use (that's next), we believe you'd be able to choose the best for yourself. With all that mind, we'd like to repeat a phrase the late Steve Jobs was known to have said many a time – "it should just, work".

THE BEST VIRTUALIZATION SOFTWARE AVAILABLE

Though there's plenty of software available, only a handful are famous, and not without reason!

Virtualization has become one of the most mature and active topics for discussion and lots of software has been created for its implementation. There are companies which specialise in the arena and put up a really good fight against competition, and then there are the open source counterparts making virtualization available to the common man without shooting holes in their pockets. While some projects (both, open and closed source) are quite big and have a lot of features, there are a few smaller ones with not so big a name and without too many features. While using them would give you an experience of virtualization, using the better ones would give (obviously) better features and better experience. The experience of virtualization depends on the features and flexibility of the virtualization software. For the same reason, we pick up the best of the trade and tell you how to go around, the features they can provide and the troubles they can bring to you. These software can be downloaded and installed with a minimum of hassle without making you want to pull out your hair. They have the best features among others and give you the best value from the free world as well as the paid. Don'te that viewing a virtual machine in full screen is a facility all the virtualization software discussed here feature so we won't talk about that specifically for each. Now, we list down the three biggies.

VMware Workstation

VMware is the biggest company focusing on the virtualization scene. In fact, it's the single biggest company standing on this single concept. It has almost everything for everyone. The one thing it doesn't have in its wide range of products is "free" software. It had been offering VMware server until some time back when it ceased support and discontinued the product. This might be a disappointment to some who think that they might have got the whole awesomeness of VMware without shelling out any money; this is far from the truth because the product had quite a few problems which badly affected many users.

VMware has almost everything from software allowing you to run single (or multiple) virtual machines on your desktop to managing a whole set of computers on a sophisticated network to bringing cloud computing at your service. On its desktop line of products, VMware Workstation is the best available software.

Installation

VMware Workstation is available for both, Windows as well as Linux systems and you can download and install them on the respective platforms.

So if you're interested, head over to its web site: *http://www.vmware.com/products/workstation/overview.html* Click the "Try for free" link and download the software (you must register for the trial, registration is free).

After registration and accepting the terms of license, you'll be presented with an option for downloading the package for either Windows (both, 32-bit and 64-bit installations can be done from the same setup file) or for Linux (there are separate versions for 32-bit and 64-bit installations).

▶ **Installation for Windows:** It's just the way you install any other software on the machine. Download the package, double-click the setup file and follow the instructions on the screen. Of course, you'll need to have access to an administrator privileged account to install the package.

▶ **Installation for Linux:** Unlike the rest of the software you download and install for Linux, VMware Workstation has no Linux repository and you can't download its source and compile either (it's a paid and closed source program). You'll have to download the bundled package from the Download page. Pay attention to the architecture type (32-bit or 64-bit) before you download. The 32-bit version won't work on the 64-bit Linux system and vice versa. We also found that even if you have enabled 32-bit libraries for your 64-bit Linux system when you installed it, VMware Workstation fails to install. Make sure that you're downloading the right package. You wouldn't want to waste more than 300 MBs of data and the time taken to download it for nothing. In case you don't know whether your Linux system is a 64-bit or a 32-bit one, start your terminal and fire the command `uname -a`

If the line contains any of the following: i386, i486, i586 or i686 then your Linux system is a 32-bit one and if it contains x86_64 then it's a 64-bit one. Upon download, you need to make the file executable. So assuming your file is located in `/home/digit/Downloads` and the name of the file is `VMware-Workstation-Full-8.0.1-528992.i386.bundle,` you should execute the command `chmod +x /home/digit/Downloads/VMware-Workstation-Full-8.0.1-528992.i386.bundle`

That will make the file executable. Just like with Windows, you need to have the administrator (or "root") privileges. So you must either run the `su` command or add `sudo` before calling up the execution of that file. Typically, sudo should do it. However, with some systems (such as Fedora), a normal user isn't in the list of users who can use the sudo command. In those cases, you first add su, then go to the directory where the file is located and execute it. To execute the file, you can go to the directory where

it's located and then run `./VMware-Workstation-Full-8.0.1-528992.i386.bundle`

With the sudo, it would look somewhat like this: `sudo ./VMware-Workstation-Full-8.0.1-528992.i386.bundle`

It executes a python script so you must have python installed on your Linux system as well. Once done, you'll get an installation wizard where you can click the "next" and "back" buttons and then hit "install". At one point of time, it will ask you to enter the name of the user who'll first connect with the server. You can enter your username instead of "root" there, but ensure that you don't use the root account to launch VMware Workstation after installation. It should be the same user whose name you entered. This is not much of a reason to worry because the setting is for "Shared VMs" which you would probably not use as an average user.

In case you're wondering about instructions for Mac OS X, here's the bad news. The VMware Workstation is unavailable for the Mac OS X. Bummer. Though, VMware has another program handy called VMware Fusion for Apple machines. The menus would differ and the options would slightly vary but the performance would stay the same. In fact, VMware Fusion, at times performs better than VMware Workstation with the same hardware configuration. It also has a few features unique to it, which is probably because of the advanced APIs available on Mac systems.

Limitations

VMware has a long list of features to keep you busy for a couple of days at least if you are one of the adventurous types. All this, though, doesn't come for free and you have to shell out $199 or approximately ₹10,000. Ensure that you have a license before using it. We don't recommend a pirated or cracked version as it may contain modifications and can damage your system. Since VMware Workstation runs a lot of its components on the kernel level (a level from where the operating system controls your machine). There are chances that if you download and install a pre-cracked version, you would suffer crashes or data theft or anything which the crackers have planted inside when they modified the code.

Moreover, it's best to have a legal installation and pay the developers for their great work. That entitles you to receive support from the company as well. In case you don't want to make the investment, VirtualBox, a free virtualization software package, has a lot to offer and is a very close competitor

to VMware Workstation in terms of features and has some extra benefits. We'll discuss about VirtualBox as well, later.
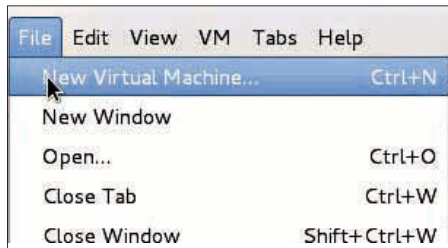
Creating a new Virtual Machine (VM)

Creating a new virtual machine in VMware Workstation is no big deal and is intuitive. We'll show you how. But before we proceed, note that we used openSUSE 12.1 with Gnome 3 and VMware Workstation version 8.0.1 for the guide here. Depending on your OS, the menu options would differ a bit and you may have a slightly different organization of buttons on the screen, but that won't be difficult to figure out at all!

To create a new virtual machine in VMware Workstation, follow the steps: Go to File menu and click "New Virtual Machine".

On the new window that opens, you have two options to configure your virtual machine for the start:

▶ **Typical (recommended):** This method, as it says is recommended. It keeps it easy on you if you're new to the virtualization scene.

▶ **Custom (advanced):**

This method, once again, as it says is for the advanced user (or a brave one who's ready for experiments, right away). You get to define a whole lot of hardware interfaces and methodologies that VMware Workstation will use

Figure 5: Menu option to create a new virtual machine

and define the machine's compatibility with other VMware products. Since it's unlikely that an average user would have the advanced tools from VMware to bother about compatibility, we wouldn't suggest this option if you don't fully understand what you're doing. Committing mistakes over here would affect the performance or stability of the guest OS you're going to use. However, you need not worry too much, for all you're going to create is a virtual machine and you can delete it anytime you want, if experimentation is all you want to do. If you're an advanced user and are going to use the virtual machine to seriously learn virtualization, you probably already know the intricacies, and if you're a new user who's ready for experiments and you don't want to use

it for serious work, go ahead and explore the options. You can always remove the virtual machine and create a new one (by the way, creating a new one and installing the OS in it does take time!). In case you're new to virtualization and want to use the virtual machine for some serious work, we don't recommend this option.

Assuming you chose the "Typical" installation method, you'll be presented with the options for source of the OS you want to install on the virtual machine. You have three options:

▸ **Install from a physical drive:** Here, you choose one of your DVD / CD drives (in case you have more than one). You need to put the guest OS installation media in the disk before you install. Workstation will try to automatically determine the OS within.

▸ **Use ISO image:** You can use an ISO image of the OS. Once again, Workstation will try to guess the OS on the media. If it makes a wrong guess, you should select the third option: "I will install the operating system later" and after creation of the virtual machine, open its settings and select the media (DVD/CD drive or an ISO file) before you launch it.

I will install the operating system later: You can use this option if you haven't decided on the OS yet or don't have the installation media. If you select this, VMware Workstation will ask you to manually set the OS you're going to use within the virtual machine.

If and when VMware Workstation tries to guess the OS inside the installation media, it allows you to provide the details for installation which includes the username and password for the OS. The feature is called "Easy install". In case of Windows, it would additionally ask you for the CD key of the OS. We wouldn't recommend providing that information before creating the virtual machine; install it normally. The reasons might not be obvious until you've actually finished the installation. At times, we found that the root user password in the guest OS wasn't set correctly and in case of Windows, a different time zone was selected. In case of a Windows XP guest, it caused problems because the full name of the user was two words and included a blank space.
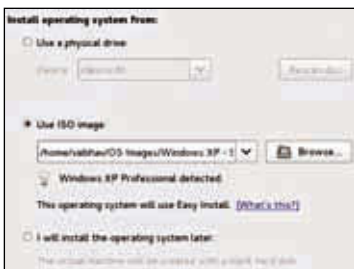
Figure 6: VMware easy install detects the OS inside the supplied media automatically

This might be a bug in the copy of the software with us alone but we don't recommend deliberately falling in trouble when you're not saving more than a few keystrokes. Once again, for the brave out there, you can experiment!

You can select the name of the virtual machine and the location of the files that will be created. You should either not change the default location, or in case you're changing it, make sure that you create a new empty directory for the purpose. Using a directory that already has files

Figure 7: Easy install feature asks for Windows installation details

will cause disorganisation and made porting the virtual machine difficult.

Next, you get to select the size of the virtual hard disk. VMware Workstation tries to make a wise decision between the free space available and the recommended size for the guest OS you're installing. If you're going to only run MS word in Windows XP (let's suppose you're installing that) virtual machine that you're creating, allocating 40 GB won't be too wise. Also, do remember that VMware Workstation doesn't allocate all the size at one go (it used to till version 7).

Allowing too much space in the beginning is not recommended if you don't need it. In cases as above, you can allocate 12-15 GB. If and when the space starts falling short, you can add another virtual hard disk later and make use of it using the guest OS (partition, format and mount it in the directory you need it).

You might choose to make the virtual hard disk into a single file or multiple files. If you need to port (copy or move to an external storage) the machine later on, go for the split files because a FAT32 partition (which most pen drives are formatted with normally) can't carry a single file any bigger than 4 GB, even if the media's total capacity is 32 GB. If you have an external hard disk which is formatted with a non-FAT32 file system, such as NTFS or Ext3 /Ext4, you can opt for the single file as well!

Also note that there's an option which you can check to allocate all the disk space right away. This will improve the performance but lock you out on all the space you have decided! Also, allocating all the space takes time!

You're at a final screen where you can customise the hardware further by clicking the "Customize Hardware..." button or just click "Finish". You can also determine whether or not you want to power on the virtual machine right after creation.

If you did not select the installation media earlier, don't start it right away. If you have the media, you can select it by clicking the hardware customization button and selecting the media in the new window that opens up (you should click on CD/DVD option for that) and then finalize the settings before you start the virtual machine.

That's it. Your virtual machine is ready to be run on your system! You can now install your desired OS and start working on it. Just click on the start button - it looks like a play button, a triangle which points to the right, and you would be installing the OS.

Features

VMware Workstation is probably the most feature-rich virtualization application you can find for a desktop. It has a long list of features and we're going to talk about the most useful ones here.

▸ VMware tools (guest add-ons): VMware calls its guest add-ons "VMware tools". With a wide range of operating system support, they provide you with a seamless experience when working on the virtual machine you created using VMware Workstation. They allow the use of a lot of other features. VMware tools are available for Windows (98, 2000, XP, Vista and 7), Linux (almost every distribution can make use of them), Solaris as well as for the FreeBSD. We don't expect you to miss the Mac here because the Mac OS X wouldn't work on any hardware other than Apple's and VMware doesn't emulate them. So, no Mac support. VMware tools facilitate the use of shared folders and visual glory inside a virtual machine which probably no other virtualization software can provide. As a matter of fact, VMware Workstation is the only virtualiza tion software you can find to support the AERO interface which was brought into Windows Vista and later versions. You may also want to install it if you're going to use any applications inside the virtual OS which require 3D support (e.g. 3D modeling or Google Earth or something else which needs you to have either DirectX or OpenGL support). To

Figure 8: Installing Windows XP inside VMware Workstation

install VMware tools, start the machine, go to the VM menu and click on "Install VMware Tools". Then follow the instructions in the guest or open the DVD drive in the guest OS and run the setup program yourself.

▸ **Snapshots and AutoProtect:** We've already mentioned about snapshots – it's a feature which allows you to save various states of the virtual machine so that you can go back to some point of time where the virtual machine was working as per your expectations. In case of problems, you can use snapshots to go to the last working state. VMware supports snapshots really well and will allow you to create a number of snapshots allowing you to take various paths of configuration of your virtual machine. If that last sentence confuses you, take a look at the snapshot manager screenshot we have for you and you'll get an idea. We also said that you should take a snapshot of the virtual machine you're using as and when it's in a state where you would want it to be. When you make big changes and don't want to lose them, take a snapshot. We don't expect you to be vigilant all the time; after all we tend to forget to press the [Ctrl + S] quite a number of times and end up losing our work just because we clicked on a "No" button when the program asked
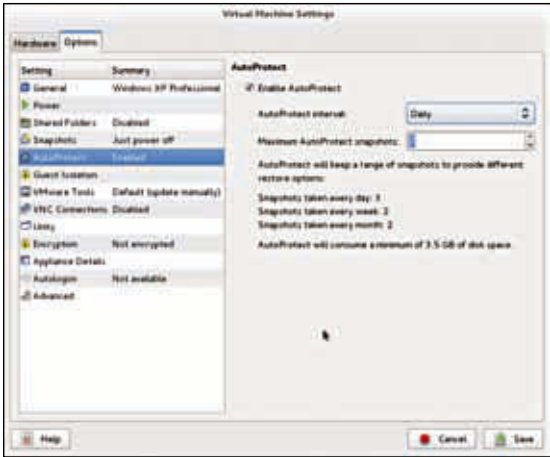
us whether we wanted to save the changes or not. One can't expect to go all wise and conscious overnight. VMware Workstation takes care of this with its AutoProtect feature.

▶ The AutoProtect feature allows VMware to take snapshots periodically for you so that in case you forget to save your work inside the virtual machine, you can at least restore the last snapshot and get back to work causing minimum hassle for you.

Figure 9: You can take multiple paths during your usage of your VMware virtual machine

▶ Just open the virtual machine settings and select the AutoProtect option in the "options" tab. You can configure VMware Workstation to take a snapshot automatically every hour, half-an-hour or on a daily basis. Increase the number of snapshots you want VMware Workstation to maintain and you'll be able to see how many snapshots will be preserved and in what pattern. Just have a look at the screenshot and you'll see the

**Figure 10**: Enabling Auto-Protect in VMware Workstation

AutoProtect feature being enabled. Notice that as we increase the number of snapshots we want AutoProtect to keep, the corresponding number of snapshots it would keep increases for different times.

This makes sure that you don't end up with a bunch of snapshots (that can affect the performance badly) and you don't lose any important work because of something else going wrong! It's still not recommended that you take important snapshots manually; rather, ask VMware to do the AutoProtect while you're working after taking an important snapshot. It's best to delete those snapshots which you think are not required. These are mostly the points where you probably wouldn't return back to, in favor of some other snapshot, for example, you would rather want to go to the "Ready for Web Development" snapshot than "Installed Ubuntu" snapshot from our previous example!

▶ **Unity:** Unity is a feature that allows you to have application windows from your virtual machine on your real working environment. You'll get a small image on your title window indicating that the window is from one of the virtual machines.

Notice the symbol on the title bar of the My Computer window inside the red mark in the picture and you'll get a fair idea of how seamless it is for you to work on the virtual machine applications on your real system. To exit Unity, you simply have to go back to the main VMware
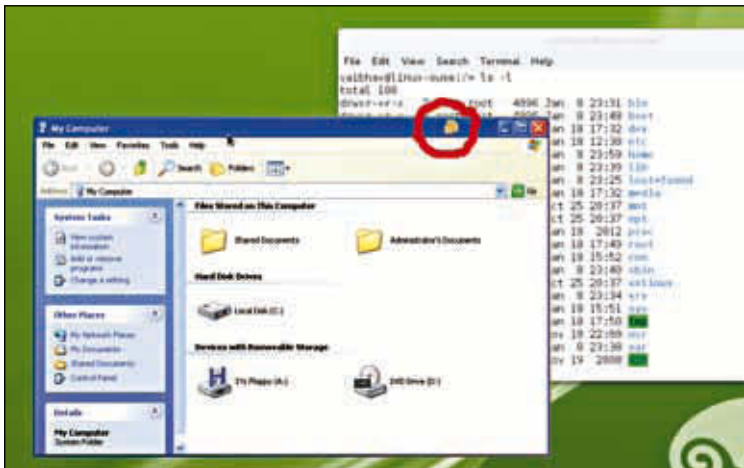
Figure 11: My Computer window in Unity from a Windows XP virtual machine on Linux

Workstation window, switch to your virtual machine's tab and click on "Exit Unity" and the virtual machine will be back in its tab! In addition to the symbol on the title bar of virtual machine windows, you also get a colored border around them which look more like an aura.

▶ **Encryption:** Encryption is a feature which allows you to password-protect your virtual machine. This includes its virtual hard disk file, the snapshots and the configuration files. You'll need a password to encrypt and decrypt the virtual machine, even if you're copying it to another machine. Although this is available as a feature, we don't recommend using it unless you have really sensitive data on the machine which you don't want anyone else to have an access to.

This feature doesn't come recommended for a few reasons:

- The performance of an encrypted virtual machine is noticeably lower than that of a normal one.
- You require the password to use it. If you tend to forget passwords, beware!
- In case something goes wrong during encryption, such as a power failure, you're at a loss. Imagine your configuration files encrypted and hard disk files unencrypted. Chaos.

If you really need to protect the data, it would be better to enable protection of the data inside your virtual machine (for example, enabling NTFS encryption on your Windows guest machine). Use this feature only when you're sure about what you're doing and having made sure to the best of your knowledge that nothing would go wrong when trying to use it.

▶ **Autologon:** This feature allows you to supply the guest username and password to VMware Workstation to which you want to log on when you switch on the guest. Although it's useful, we'd rather prefer using the guest OS for doing this job.

▶ **Guest Isolation:** This feature allows you to seamlessly copy files from your guest OS to your host OS by dragging and dropping. You can also do a [Ctrl+C] in your guest and [Ctrl+V] in your host or vice versa. This is what we were talking about when we mentioned bi-directional clipboards in a previous chapter. Dragging and dropping files to copy between guest and host is an immensely useful feature which only VMware Workstation supports among other desktop virtualization programs. Use it and you'll come to know why it's so useful.

▶ **Shared Folders:** This feature, as mentioned before allows you to make use of your folders / directories on your host OS in the guest OS. Work-

station would also automatically mount them as network drives in a Windows guest, if you opt for that. Another very useful feature.

▶ **Autoresize:** You can go to `View > Autoresize` on the main Workstation window for options to help you with how the virtual machine running inside will look when you resize the VMware Workstation window itself! It's best to keep it as "Autofit guest" for the most intuitive experience.

▶ **Recording a movie:** Yet another marvelous feature of VMware Workstation not found in other virtualization software is its ability to record a movie! You can access this option when the machine is running, in the "VM" menu at the top of the main screen. Use your imagination and the video could end up on YouTube with high numbers of views. For students, it's an exciting way to get help on complex software. For example, if you have a really complex networking software for your lab and you don't know how exactly to operate it, all you need is your laptop (assuming

Figure 12: Autoresize can make your VM resolution according to available size on window

you have one). Install VMware Workstation inside it. Now create a virtual machine, install the required operating system and software inside it. Click on the option to start recording a movie. Then ask the lab assistant or your lecturer to help you with it. Once done, you have the whole tutorial with you in video mode. You can go through it as many times as required to learn it well without having to worry about irritating your teacher. You can also distribute the movie to your friends or put it on YouTube to assist others who might be just as troubled with the workflow as you once were! Days for asking your friends about "How to work on the 7th program" might just be over! You can use this awesome feature in many ways. This was just a small example! You wouldn't find yourself in a lot of trouble for things which you "once did but forgot". This is one of those features of VMware Workstation which would make an average user want to shell out money and buy the product. Really interesting and helpful.

▶ **Debugging:** This is one thing you're going to love in VMware if you're into kernel debugging. The reason is simple – VMware Workstation is a virtu-

alization software; it runs operating systems. Gathering advanced debugging info about running the running OS is useful for the guys deep into code and a lot of memory junk that comes along. Not at all meant for the average user, it's one of those features that set VMware Workstation apart from others especially when it comes with so many other useful features. These features (except Autoresize) are available in the virtual machine's settings window's "Options" tab. To open it, select the tab and go to `VM > Settings` on the main window or you can also right-click the VM's name in the library pane and select the "Settings" option at the bottom. In addition to the above, you can change a few things about the virtual hardware on the "Hardware" tab of the VM's settings window. You can add or remove new storage media, network cards, audio and USB ports and so on; after all, they are all "virtual"! However, you can't remove the Processor, Memory or Display. You can only change the settings – adding more cores to the virtual processor available to your machine, increasing / decreasing the amount of memory to be consumed and acceleration of 3D graphics and setting resolutions of the display. Also note that when the virtual machine is running, you can't add new hardware. You can only enable or disable a few of them. If you're able to add a few new hardware components such as hard disk or dvd/cd drive, you'll only be able to use them upon rebooting the virtual machine. This is because you can't do that on a real system as well and the operating systems are designed assuming that you don't pull out your RAM modules from the CPU when the system is running or do somehing as crazy as that!

▸ **Note for Linux users:** At times, VMware complains that a particular module is not loaded, just when you press the start button for the virtual machine. The error would typically inform you which module was not loaded. In such scenarios, you can switch to the root account (run the `su` command) and load those modules with the `modprobe` command.

Once the command runs successfully, you can retry starting the machine and it should work! If it doesn't, run to the internet forums or the VMware support team for help!

Figure 13: VMware workstation complaining the unavailability of the vmmon kernel module

You can disconnect and reconnect a few virtual hardware while the guest OS is running. You can right-click the activity icons at the bottom right corner of the VMware

Workstation's main window (with the tab of the concerned guest OS selected) and open the settings or disconnect / connect the hardware.

Figure 14: Load the kernel modules with the modprobe command

VMware Workstation is bad for...

Now it's time we told you about the flipside of using this software. First and foremost, it's cost is pretty high – a whopping $199 / approximately ₹10,000. That's costly in all senses for a normal guy playing around with his machine at home. Unless you have that kind of money to liberally spend or are in deliberate need of some of the exclusive features of VMware Workstation, there may not be a real need to buy it. VMware Workstation is for Workstations. A workstation, if you didn't know is a desktop computer used for work. They're usually more powerful than the average home PC and are mostly used in offices. The configuration of a mid-range gaming system is what you could normally call a workstation configuration. VMware Workstation was designed for people who use their systems for some serious work and we recommend keeping it that way unless you're a rich enthusiast or someone who uses his home PC for work (e.g. small business owners).

As if you didn't know already by now, we're going to repeat ourselves – VMware Workstation has plenty of useful features. That directly translates into more resource-hungry virtualization. You don't want to install it if you're short on RAM or have a lower-end processor. In case you don't have at least 1.5 GB of RAM and at least a dual core processor and can't shake off the mood to buy the VMware Workstation, we suggest you rather spend that money upgrading your system configuration and installing free software for virtualization instead. VirtualBox is another great virtualization software and would give you an experience close to VMware Workstation (save a few exclusive features such as great 3D support, AERO support, encryption, autoprotect, debugging and guest isolation). However, if you have a computer with a good configuration and have the money to spend for a great experience of virtual machines, there is no reason to shy away from VMware Workstation either! **d**

VIRTUALBOX

Let's check out another great virtualisation software

V irtualBox was a new kid on the block a few years ago and didn't have too many features. No more; the kid is growing and has gained attention. VirtualBox, as of now, is one of the most popular desktop virtualization solutions. One of

the biggest reasons behind this has been the names associated with it. VirtualBox was developed by a relatively small company (compared to its current owner) named Innotek. The company was later acquired by Sun Microsystems which in turn was bought by Oracle. Since the acquisition of Innotek by Sun, VirtualBox gained a lot of speed in development as well as acceptance by users. Its popularity only increased when Sun was acquired by Oracle. VirtualBox is a free product and there's no need to pay anything to anyone. It's licensed under GPL which means that you can have a look at the source code as well! This is one of the reasons for VirtualBox rising towards the top of the list in virtualization. Another asset by its side was being cross platform. This ensures that the software is well received by almost everyone who wants virtualization software. It runs on all the supported versions of Windows as well as on Linux and Mac OS X. Although you'd rarely find anyone using Solaris on their desktops, that too is supported! VirtualBox has plenty of features in demand by most users. But before we get into that, let's first see how to get it running.

Installation

Installing VirtualBox is easy. For Windows, as usual, you get the setup file and double-click it. Once again, admin privileges are required. For Mac OS X too, the usual install procedure would work well. For Linux, there are three ways in which you can do this:

1. Search for the VirtualBox package in your distribution's software repositories. There's a high probability that they're available. If they are, download and install them. All the required modules and dependencies are installed automatically.

2. Go to the VirtualBox web site and open the link to the page for Linux download (*https://www.virtualbox.org/wiki/Linux_Downloads).* Then select the right architecture and distribution for which you want to download. You can once again use `uname` –a command to find your architecture (mentioned in the VMware Workstation installation section; in case you skipped it).

3. Download the sources and compile it from scratch if everything fails. Don't forget to go through the build instructions.

VirtualBox can in fact be built (compiled) on every supported platform and the build instructions are located at *https://www.virtualbox.org/wiki/ Build_instructions.* You'd find links to build instructions for different oper-

ating systems on that page. Select the one you're interested in and follow them. We won't get into instructions on how to compile VirtualBox as that's one really lengthy topic and too huge to be covered in one Fast Track. VirtualBox installation will reset your internet connection. Make sure you're not downloading something before you start the installation. Before going forward, note here that we used VirtualBox version 4.1.4.

Creating a new virtual machine in VirtualBox

Creating a new virtual machine in VirtualBox is as intuitive and easy as it is with VMware Workstation. However, at times installation of VirtualBox is not so smooth and the software doesn't work straight away after installation. Here are a few problems which VirtualBox is known to exihibit since quite some time.

▸ Not all required files are installed in the first go. We faced this problem in the past in particular, when installing on Windows machines. On trying to start VirtualBox in such a case, it would give you an error code and close itself. While this is not the case anymore as we notice, it might just come up for someone. So just in case it does, try uninstalling VirtualBox and after a reboot install it again. It should work fine.

▸ On Linux systems, VirtualBox installation at times doesn't add you to the "vboxusers" group and you have to do that manually. This is a problem at the end of the installer script's end. On installing VirtualBox on our openSUSE 12.1 test system, we didn't come across this problem. Same was the case with the latest release of Ubuntu – Oneiric Ocelot (11.10).

▸ If you do face the error message saying that you're not in the vboxusers group, try to run the command:
```
useradd –G vboxusers digit
```

▸ You must execute this command with root privileges (use the su or the sudo command). Note that here "digit" is the username. You should replace it with your own username (not the full name).

If you've already installed VMware Workstation and are trying to install VirtualBox as well, you're probably calling for troubles, and big ones. While they may both work well at the same time, there is no guarantee for that and you should not be surprised if both of them freeze or your whole system freezes. You may as well expect your host OS getting corrupted. Pick up just one and go with it. Don't launch them both at one time either. While we didn't face troubles when testing this time, we've bumped into

corrupted hosts operating systems in the past when we tried to install both of them on a single machine. This happened with both, Windows and Linux (we noticed Ubuntu 10.10 and openSUSE 11.2 crashing). We don't recommend installing both virtualization software at once.

Creating a new virtual machine

Once you've installed and configured VirtualBox correctly, you can click on the "New" button on its main window to get started. The following would start happening:

▸ A window would come up saying that the wizard will guide you through the creation of a new virtual machine and so on. Click "next" to continue.

▸ VirtualBox will ask you the name and the "type" of operating system you intend to use the virtual machine for. The "type" is actually the OS family (such as "Windows" or "Linux") and version / distribution (e.g. "Windows XP", "Fedora") of the OS. Just start typing the name of the OS in the box provided and if what you type matches with the name and edition of a supported guest OS then VirtualBox will automatically choose the right matche for you. For example, try typing "Ubuntu" as the name and the OS type automatically changes to "Linux" and the version changes to "Ubuntu". Intuitive, isn't it? Click "next".

▸ VirtualBox will now ask you to decide on the capacity of RAM you want to allocate to the OS. Depending on the family and the version of the operating system you selected in the previous step, VirtualBox tries to make a wise decision. For example, if you've selected "Windows" / "Windows XP" as the family / version of the OS, VirtualBox will set the RAM capacity by default to 192 MB. If you select "Windows" / "Windows 7", it sets the default to 512 MB. Remember that these are the defaults the VirtualBox has set for you. Since you're the master here, you must decide what feats you want to perform in the virtual machine and set the desired RAM allocation accordingly.

▸ In this step, you've to decide whether you want to use a hard disk or not. Well, you can use the virtual machine without one! If you've ever used a live Linux system (like ubuntu) which doesn't make use of the hard disk, you'd know! In most cases you're going to use a hard disk. You'll have the option to create a new one or use another existing one. If you're trying to make use of a virtual hard disk file which you copied from somewhere, you can select the "Use existing hard disk" and click on the browse button to locate it and use it. By default VirtualBox will

list the virtual hard disk files known to it. The list would usually be of the virtual hard disk files of the machines you've already created and might include the ones from those virtual machines which you removed from VirtualBox but didn't delete them altogether from the disk. This allows you to re-use the old operating systems you had removed from the list. If you're creating an entirely new virtual machine, select the "create new hard disk" option and click next. It will open a new window on top of the old one. We assume you're going to create a new hard disk.

▸ The new virtual hard disk creation wizard should be up now. What you'll see here might just astonish you. VirtualBox indeed supports a total of 4 different hard disk types.

The different virtual HDD formats supported by VirtualBox are:
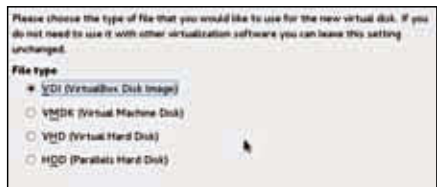
Figure 15: VirtualBox supports quite a list of file types for creating a new virtual hard disk

▸ **VDI (VirtualBox Disk Image):** This is the native file type used by VirtualBox for virtual machines and will give you the highest amount of flexibility and performance. Use this if you plan to use the hard disk or the virtual machine on VirtualBox and don't intend to give it to others.

▸ **VMDK (Virtual Machine Disk):** This file format is used by VMware Workstation and other VMware products. So, in case you're planning to use the virtual machine on a VMware product (such as VMware Workstation or VMware Player) later, this is your best bet!

▸ **VHD (Virtual Hard Disk):** This file format is used by Microsoft Virtual PC and Hyper-V virtualization system in Windows server. If you plan to use the machine on one of those, this is the one you want to use. In fact, Windows 7 supports booting from a VHD disk if you set the right parameters in the boot configuration database (you can modify it with bcdedit.exe). This might not work at all as the image you'd install later in VirtualBox would not be generalized. More instructions for the hardcore geeks and the brave at heart, the explorers at *http://technet. microsoft.com/en-us/edge/ff944958.*

▸ **HDD (Parallels Hard Disk):** This file format is used by the virtualization software called Parallels. This software is equally decent

and comes with a unique feature which most other general purpose virtualization software don't possess – porting real systems to virtual machines. While that's not impossible and there are ways around if you're going to use some advanced Linux commands, it's obviously dangerous. Anyway, this file format would allow your virtual machine to run on the "parallels" virtualization software packages.

Now that you know the benefits of the various formats, select the one which suits your needs and press "next".

Now you get the option to select whether the file should be "dynamically allocated" or "fixed sized". We recommend "dynamically allocated" for it saves the space which you won't be using in the virtual machine.

You get to select the filename and the location as well as the size of the file. It's better not to alter the default file location as they are usually good places and are easy to find. However, if you don't have enough space on the partition that the file is about to be created, well, change it to something else. Also, set the desired space (in case of a "dynamically allocated" image, this is the maximum space that would get allocated) for the virtual hard disk file. Press the next button. On the next screen, press the "Create" button to create the file.

Now you're done and have to press the "Create" button again to create the virtual machine and add it to the list of virtual machines in VirtualBox.

That is all, you have the machine ready. Unlike VMware Workstation, VirtualBox doesn't ask you to set the installation image and some other info. To set them, select the virtual machine you just created from the list and click on the "Settings" button. This will open a new window. Click on the "Storage" option on the left and then click on the DVD/CD icon in the list (it should be labeled "Empty"). When you select it, you'd find the option to alter the settings to the right (inside the "Attributes" section). You'll be able to change the drive type to "IDE Secondary" or "IDE Primary" and so on. Besides that, you'll find a button with an image of a CD on it. Click it for the options. You can either select a physical drive or select an ISO image to be used as the DVD/CD inside the VM. Choose one according to your needs and finalize the settings. In case you don't specifically set the DVD/CD drive or the ISO file to be used as installation media, VirtualBox will ask you on a dialog box for that when you first start the machine. Remember that this will happen once. If you close the dialog box without choosing any option, VirtualBox probably takes it as a personal insult and never asks you again. So ensure you change the settings mentioned above.

On the same window (the settings window) you have options to add or remove other hardware, set the shared folders, network interfaces and so on. Explore your options and make the changes you want to and confirm the settings by clicking the "OK" button. Also remember that this is the same window you're going to come back to if you need to change settings later on. Although we want to, this space isn't enough to tell you about all the options that VirtualBox has in store for you. Just go, explore them all!

Your new virtual machine should be created now. Select it from the list presented to you and press the "Start" button to start installing the OS.

Features

The feature-set of VirtualBox is not too great when compared to VMware Workstation, nonetheless it's an impressive one and a general user as such would find it useful.

▸ **Virtual Machines in their own windows:** Unlike VMware Workstation which would run all the virtual machines inside its main application window as separate "tabs", VirtualBox will open a new window for each virtual machine as and when you start them. This makes sure that your guest OS has much more screen space and you're able to get the most benefit out of the larger screen, thus elevating your experience with the virtual machine.

▸ **Guest Additions:** This is the name VirtualBox uses for its guest add-ons. Once installed, you'll get a better graphics performance and auto-resize capability on the guest OS along with the ability to mount your shared folders as network drives. It will also improve your network response times (so you could experience a faster network experience inside the guest OS). Also, you'll be able to avail hardware acceleration and bi-directional clipboard. In some conditions (depending on the guest OS), it also brings in the capability of audio playback to your guest OS, which might otherwise be missing (when the guest OS is not able to detect and make use of the emulated audio device).

▸ **Auto Resize:** This feature is same as that in VMware Workstation and allows the display inside the virtual machine to be dynamically changed. Since VirtualBox uses separate windows for each virtual machine that you're running, it simply means that you can use maximum of your screen space without having to switch to full screen.

▸ **Execution cap on processor:** Not only does VirtualBox allow you to set the number of processors that the guest operating system can use,

NOTE FOR LINUX USERS

When you install VirtualBox from your distribution's online software repositories, or by downloading the corresponding .rpm or .deb setup files from the web site, you don't get the VirtualBox guest additions with it. When you first try to install them from the "Devices" menu on the virtual machine's window, Virtual-Box will report to you that the guest additions are not available and offer you to download them separately. Select "yes" for the option and wait for the download to complete. Once done, go again to the "Devices" menu and select "Install Guest Additions" option and VirtualBox will unmount the currently mounted DVD image / drive and mount the VirtualBox guest additions ISO file. Depending on your guest, you should now be able to install the guest additions. For Windows guest, click on the setup file inside the virtual DVD/CD drive. For Linux guests, you should open the terminal window in the guest and run the setup file manually with root privileges (once again, the `su` or `sudo` command).

Note that VirtualBox will unmount the current ISO file mounted into the virtual DVD/CD drive of the guest. Hence, you must make sure before installing "guest additions" that you're not using the virtual CD/DVD drive inside your guest OS to avoid problems.

it also allows you to put up a limit on the amount of load the guest can put on the processor. This feature allows you to have more control over the resource usage of your host system.

For example, if you're using VirtualBox as well as a few other resource intensive applications on your system and you started a resource-hungry process in the guest OS (let's say you're converting audio files from one format to another), this feature will make sure that the guest operating system doesn't consume all the processing power. It ensures that you can work on your host system while allowing some processor-hungry application in the guest operating system run as a background operation. The feature is extremely useful for users who don't have much processor power in their PCs and want to make sure that running virtual machine s doesn't slow down everything else. It's also useful in (indirectly) setting the priorities of the virtual machines, when more than one is running – you can set the first one to run slower and the other(s) to run faster. Used wisely, it can save a lot of trouble. Though, you should always remember that when

you enable this feature and set the execution cap below 100 per cent, you're calling for slower performance. But worry not; this is one setting you can change while the guest virtual machine is still running. So when you've completed the "background" operation or are ready to give your full attention only to the virtual machine, just open the main window of VirtualBox and then the settings for the concerned virtual machine. You'll find the option located under "Processor" tab in the "System" category (that's where the setting is located)! You won't find this feature in VMware Workstation, or for that matter any other virtualization software!

▶ **Multiple virtual hard disk formats:** We've covered this in the section about the creation of a new virtual machine in VirtualBox. Allow us to elaborate a bit on its uses.

There are times when you need to create a virtual machine for someone else. It might be for the distribution purpose or for helping your friend, such as setting up a complete development environment in Linux (that one is complex for people who've not tried Linux yet, and many have not!) and then giving it to your friend. Now, assuming that your friend already has VMware Workstation installed, you'd be at a loss because then, if you were to help him by giving a virtual machine, you too would have to download and install VMware Workstation or it would be your friend who would need to install VirtualBox! Either way, you're spending more time and resources for getting a simple job done.

VirtualBox allows you to solve the problem quite easily. All you've to do is to create the virtual hard disk file in a format which would be recognized by VMware Workstation installed on his computer! This is one great benefit. In this case, you can simply create a new machine with the virtual hard disk file in the VMDK format and give the file to your friend. He would be able to create a new virtual machine on his system utilizing the file you gave as the virtual hard disk in VMware Workstation. Not only can you help your friends, you can also help yourself when you have VirtualBox installed on one of your computers you use and VMware Workstation installed on the other! It is one of the best known features of VirtualBox.

▶ **Seamless mode:** Seamless mode is the name VirtualBox gives to its ability to present the virtual machine windows as normal windows on the host operating system's desktop. This feature is similar to VMware
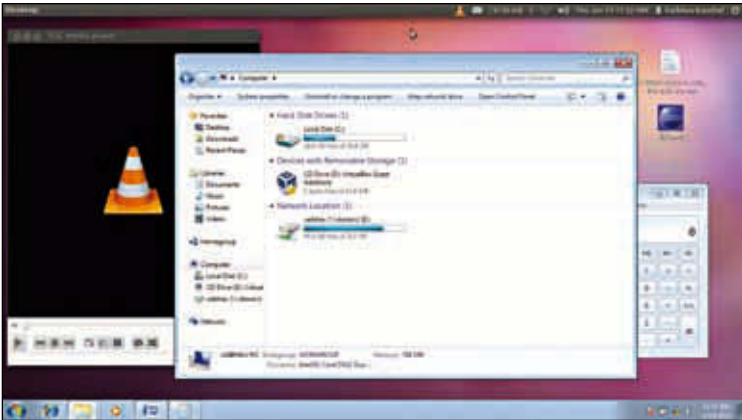
Figure 16: Explorer and Calculator of Windows 7 in Seamless mode in VirtualBox running on Ubuntu

Workstation's "Unity" feature. You can activate it after starting the virtual machine. Just go to the virtual machine's window and on the top menu bar, click on `View > Switch to Seamless Mode`. Once done, you'll have the guest operating system's windows on your host operating system as if they were normal windows.

You can see in the screenshot provided that two windows, one of the calculator application and the other of the Windows Explorer from a Windows 7 guest are put on a Ubuntu host's desktop just like normal windows while a VLC media player window from Ubuntu is also present on the same desktop. The seamless mode of VirtualBox in some ways is better than VMware Workstation's Unity feature. As you'd be able to see in the screenshot, VirtualBox in seamless mode has also enabled the almighty Windows taskbar on the host screen. This simply means that you'll be able to minimize the applications and restore or maximize them later just as you did with the virtual machine being run in its own window. This provides a lot of ease of use, especially when you have to switch between different windows from both, your guest and the host and you're someone who tends to minimize windows too much. With VMware Workstation's Unity feature, you won't be able to restore a window if you minimized it, unless and until you exit Unity and restore the window in the virtual machine's tab.

On the other hand, VirtualBox's seamless mode, unlike VMware Workstation's Unity, fails to provide a visual difference on screen between the guest operating system and host operating system's application windows. In a scenario when you have same operating system as your guest as well as host (say a Ubuntu guest on a Ubuntu host) or visually similar ones (such as a Windows Vista guest on a Windows 7 host or a Fedora 16 guest on a openSUSE 12.1 host), it will easily get confusing when switching between guest and host application windows. Moreover, seamless mode is for use only when you have to switch between guest and host application windows too often. To avoid confusion at such times, you should only keep those application windows from both guest and the host operating system visible between which you need to switch frequently and you should be fine. Despite the few shortcomings of VirtualBox's seamless mode, it's a great feature (more so, when you look at the price – it's free).

▸ **Snapshots:** Just like VMware Workstation, VirtualBox also facilitates snapshots and have almost the same features as VMware Workstation; like having the ability to take multiple snapshots, ability to take a snapshot while the machine is running and reverting back to a snapshot of your choice in case you want to go back in time. In addition to this, when you're trying to go back to a snapshot, VirtualBox will humbly ask you to take a snapshot of the present state. This is to make sure that in case you've done some important changes to the virtual machine since you last took a snapshot, those changes don't get lost. Although asking the user to take a new snapshot of the current state before reverting to a previous one is too small a feature, it's helpful. More so, when VirtualBox doesn't have anything like VMware Workstation's AutoProtect feature.

We're sure that there's not much more one would ask from VirtualBox if you're a general desktop user looking for some experimentation and minor work inside a different operating system than the one installed on your computer. VirtualBox has no support for guest isolation, autologon, movie recording (although you can take a screenshot) or VM encryption but that should be fine with any average user wanting to try out virtualization in an easy-to-use way without having to pay anything. A lot of development work is in progress on VirtualBox's part and it's expected to provide better support for 3D acceleration and AERO support in the next major release, though nothing can be guaranteed.

Why it's bad despite being one of the best

VirtualBox, as we've said, is one of the best available software for the purpose. There are no other free and open source products which provide performance like VirtualBox does on every aspect, that too when being completely cross-platform and free of cost! In other words, the value of VirtualBox is unmatched in the virtualization scene for those who simply want great virtualization software for general purpose use without having to spend money. However, just like with any other software, VirtualBox too has its own share of troubles. Here are a few:

‣ VirtualBox doesn't provide great support for 3D acceleration. This translates to lack of performance and significant issues if you're planning to use anything inside a VirtualBox guest operating system which would demand DirectX or OpenGL support. We certainly don't recommend running any graphics-intensive applications inside VirtualBox. It would simply not work well. However, for lightweight apps which require some 3D support such as Google Earth, activate the 3D acceleration on the guest machine's display settings and you should be fine.

‣ VirtualBox doesn't support split virtual hard disks of smaller sizes. Hence, you must split the files yourself if you want to transport them to another removable media. This isn't a major setback because almost everyone has software like WinZip and WinRar installed on their systems (Linux users should have similar software preinstalled as well). Compressing and splitting your virtual machine's directory shouldn't be a great problem.

‣ VirtualBox isn't fun for debugging operating systems. In case you're one of those who love to get inside the code, and deep, get yourself VMware Workstation. VirtualBox won't support a lot of what you'd need there. For example, if you're trying to debug a Windows guest kernel, there are ways in which VMware Workstation can help you do that quite a lot (you should preferably have same version of Windows as both, guest and host, and a deep understanding of the technique). VirtualBox doesn't come with all those hidden features you need when you're getting adventurous with operating system internals.

‣ Lack of autoprotect is another thing you might really be missing if you happen to use VirtualBox for some serious work on your virtual machine. Make sure you take snapshots regularly. You don't have automation here.

Having said all that, VirtualBox is still one of the best things you can have you hands at for free and just like we'd said earlier, VMware Workstation is for people who use virtualization for serious work rather than experimentation. If you're a developer and your work doesn't concern anything 3D, VirtualBox would suit you; as long as you take care of regular snapshots. Now that you know the differences between VirtualBox and VMware Workstation, it's your turn to pick either one. If you still want more options, read on.

QEMU / KVM

Advantages and disadvantages of using this software. Also, find out other software options

F or a Linux user, the command line is one essential part of life. If you use Linux, chances are you'll find yourself using a command terminal quite often. There's no escape when you have great features.

The Linux-only virtualization

Qemu and KVM put together are Linux specialists in virtualization. Did you just think "Hey, what about VirtualBox and VMware Workstation"? Well, we call Qemu and KVM as Linux specialist software in virtualization due to two reasons:

▶ KVM stands for Kernel-based Virtual Machine. It's a Linux kernel module.

▶ Qemu, although it can work on Windows, is more suitable for Linux.

We call Qemu/KVM as Linux-only virtualization because Qemu in itself performs poorly without KVM and with better options available, perhaps no one would want to use Qemu. KVM is the Linux kernel module which helps a virtual machine leverage the benefits of the virtualization assistive technologies built into modern processors (Intel VT-X and AMD-D). Combining KVM and Qemu, one gets a nice set of features with great performance. It's this increase in performance which led to the development of a separate branch of Qemu called Qemu-KVM. It combined and integrated Qemu with KVM and performs a lot better. As such, this section is only for Linux guys.

Installation

Installing Qemu and KVM is not very difficult. Just use your package manager to install the packages kvm, qemu-kvm and virt-manager. There are a lot of those packages which will install themselves as dependencies. The total download size should be between 10 and 30 MB, depending on the packages already installed.

Usage

Using Qemu/KVM is not as easy as the other two virtualization software we've discussed. You need the command line. If luck favoured you and virt-manager package was installed properly, you might just run that and get your good share of ease-of-use. The virt-manager package is actually GUI-based and uses a library (named "libvirt") to command Qemu. If you have it installed and working correctly, use it to create a new virtual machine. The wizard won't be difficult to follow for it lacks most features compared to other virtualization software we talked about till now.

There are quite a few chances that virt-manager won't behave as you might expect it to. We found errors that varied from one Linux distribution to another. While in Fedora, it complained about not finding KVM when we tried to create a new virtual machine. It asked us to use only the root account on openSUSE and simply dumped a segmentation fault on Ubuntu! So here's how to go about Qemu with the command line.

Before anything, you must load the KVM module into the kernel. For this, issue the command as root:

```
modprobe kvm
```

Depending on your Linux distribution, it might throw an error saying that the module wasn't found! This would be OK. So don't freak out. You need to load a separate KVM module depending on your processor. For Intel processor:

`modprobe kvm-intel`

For AMD processors:

`modprobe kvm-amd`

If the above commands spit out an error saying that the module isn't available, then you've got bad luck and you're unable to use KVM accelerations with Qemu. We assume that KVM module was loaded with the above commands. In case it failed and you still want to use Qemu, in all the commands that follow, you need to change the word "qemu-kvm" to just "qemu".

Now, since the module is loaded, it's time to create a virtual hard disk file. Qemu supports a few formats for virtual hard disk file that you can use to run the virtual machine later on. Interestingly enough, it supports the VMDK and VDI file types (though only of quite older versions of VMware Workstation and VirtualBox). We don't recommend creating a hard disk file in VDI or VMDK format unless creating the virtual disk and using it later in VirtualBox or VMware Workstation is the thing you're going to do. Qemu has its own virtual hard disk types as well and you can use them. You can use the `dd` command to create a RAW virtual hard disk file which can be used by Qemu or you can use the qemu-img command to create one in a desired format.

Using the `qemu-img` command:

`qemu-img create -f qcow2 windows.hdd 8G`

This will create a file named as "windows.hdd" with 8 GB capacity in the "qcow2" format. Remember that Qemu can be used to create snapshots of machines you use with it (details at: *http://wiki.qemu.org/Documentation/ CreateSnapshot)* but it needs the qcow2 format for that to happen.

Using the dd command:

`dd if=/dev/zero of=./windows.hdd bs=1M count=8192`

Here we're asking the dd command to create a file named "windows. hdd" in the current directory with 8192 blocks of 1 MB (that's 8 GB) and fill it with zeros. We used this method when testing. Also, if the `qemu-img` command is unavailable, the dd command will get the job done.

The virtual hard disk file is created. We now need to install an operating system inside it. We'll try to install Windows XP. Issue the following command at the command line:

```
qemu-kvm -hda ./windows.hdd -cdrom /home/digit/ISOs/Windows.
iso -boot d -m 256 -localtime
```

The various parameters we passed to qemu-kvm are:

▸ **-hda ./windows.hdd:** Use the windows.hdd file in current directory as the first hard disk. You can use whatever filename you gave to the virtual hard disk file you created. Absolute pathnames will also work.

▸ **-cdrom /home/digit/ISOs/Windows.iso:** Use file /home/digit/ISOs/Windows.iso as the CD/DVD device. You can use the device name of the physical DVD/CD drive as well (usually /dev/cdrom would do it if you have only one optical drive).

▸ **-boot d:** Boot using the CD drive allocated.

▸ **-m 256:** Provide 256 MB of RAM to the virtual machine.

▸ **-localtime:** Use the current time of the machine into the virtual machine. When you don't provide this option, time inside the virtual machine can be several hours ahead or behind the current time.

When you pass the above command, you'll see a new window come up which starts the install procedure from the CD image you pointed Qemu to. It will automatically reboot the virtual machine during the installation. All this time the terminal you issue the command from should remain open. If you close the terminal, the Qemu window will instantly close itself. To avoid this behavior, append the "&" character at the end of the command. The command won't become:

```
qemu-kvm -hda ./windows.hdd -cdrom /home/digit/ISOs/Windows.
iso -boot d -m 256 -localtime &
```

Let the installation complete. Then you can use the following command to boot into the virtual machine:

```
qemu-kvm -hda ./windows.hdd -cdrom /home/digit/ISOs/Windows.
iso -boot c -m 256 -localtime &
```

The only thing you need to change in the command is the boot parameter. We change the boot parameter from -boot d to -boot c. This asks Qemu to use the hard disk for booting. You can use this command from now on to boot into your Qemu virtual machine anytime you want!

It's clearly evident that running Qemu isn't going to be a piece of cake. There are a lot of troubles before everything starts running. But if you were lucky and virt-manager got installed, we recommend using it to your benefit. You would find it in the "System Tools" menu under Gnome.

Figure 17: Windows XP guest running on Qemu (openSUSE 12.1)

Advantages

By no means does this cryptic command line syntax come closer to the ease of use provided by VirtualBox and VMware Workstation. What are the benefits of Qemu/KVM then, you ask? Well, there's one factor which really adds stars to Qemu/KVM – processing performance.

Even under heavy workloads, Qemu/KVM is known to degrade the processing performance of the virtual machine by no more than 7 per cent. This is the one thing which sets this virtualization combo (Qemu and KVM are two different packages working together) from the rest. In addition, you can actually make a Qemu virtual machine run in the background. This makes it so very easy to be used for remote virtual machines. Performance is perhaps the only benefit you have here. Use Qemu/KVM if you're going to use the virtual machine for performance-intensive tasks.

Disadvantages

Now that you've read and probably used VirtualBox and VMware Workstation, Qemu/KVM have a lot of disadvantages compared to them. The duo would give you poor (really poor) graphics performance. Unless you use the

NOTE

There are a lot of options Qemu can provide you. It can allow you to use multiple hard disk files at once, emulate USB drives, network interfaces and a whole lot more. We won't tell you about all of them. You can learn about the various options provided by issuing the command:

```
qemu-kvm –help
```

Also, note that there' a command line option which Qemu provides you with to go full screen on your Qemu virtual machine: -full-screen option. Make sure you use it only when you know that all other parameters passed are correct and you're not going to get stuck at some point while the guest operating system is still running. This is because Qemu won't allow you to leave the fullscreen easily. We couldn't find a way except killing the X-Server.

Also remember that Qemu requires the kqemu kernel module. Without that Qemu is only a processor emulator, not a virtualization package. Installing Qemu would usually install the kernel module as well but we mention it separately because at times, the kernel module may not be added and you would need to "modprobe" it.

Additionally, you can use the command "qemu" rather than "qemu-kvm" and provide it with an option to utilize the KVM module but the performance and stability of qemu-kvm is way better because it's a separate project created for the dedicated support of KVM into Qemu.

command line to create qcow2 format images with Qemu and then create backed images, there's no way to get snapshots. No 3D support. Support for audio isn't that great either. Yeah, bummer. Processing performance is the only benefit here with Qemu/KVM.

Apart from this, if you've got only Qemu and KVM isn't present, even processing improvements will go downhill, all the way. The reason is Qemu, in itself is not too great a virtualization software because that was not the main use of it. Qemu, as a matter of fact, was created to emulate various processors. So you could emulate a 64-bit computer on a 32-bit one. You could emulate SPARC (various versions), ARM and even PowerPC architectures on an Intel machine. Yes, that was the actual use of Qemu. It slowly developed into a virtualization software but processor architecture emulation is still its area of expertise, and it stands tall in the OSS arena. For a decent enough performance from Qemu, you're going to require KVM.

Other virtualization software

Although VirtualBox and VMware workstation rule the show, there are a few others which are not so famous. The list would include:

▶ **Microsoft Virtual PC:** This software is an offering from the behemoth itself. However, there are limitations with it. First, it was never said to give good performance; nor was it ever high on the features list. In addition, it can only work on Windows which means that it's completely useless for a Linux or Mac user. All in all, this makes it a not-so-good virtualization software package.

▶ **Hyper-V:** You can call it the KVM for Windows. Hyper-V is the virtualization feature built into Windows Server 2008. It allows you to make use of the virtualization assistive technologies (Intel VT-x and AMD-V) on the Windows Server machine. It can be used for creating cloud computing infrastructure or for providing virtual machines as a service over the network. Since the Windows "Server" series of operating systems are not for normal users, this one isn't one of those you might want to use.

▶ **Parallels:** We mentioned Parallels when talking about the various hard disk formats supported by VirtualBox. Parallels, like VMware, is a company with a complete range of products. The Parallels Workstation is its desktop virtualization product. Although a lot cheaper than VMware Workstation, it offers some good features. The features however are close to those of VirtualBox rather than VMware Workstation. Download the trial and see for yourself. One unique feature of Parallels Workstation is its ability to package your running machine into a virtual hard disk which could be booted on Parallels Workstation; but that's not so smooth in any way. The biggest trouble you'd run into – it simply tries to bunch everything together! So you don't have the option of selecting the folders you don't want in the target virtual hard disk. Your tens of GBs of multimedia collection is what would make the overall size of the target quite huge. If you have 320GB hard disk space in total, chances are you have at least half of it filled up. Now imagine transferring 160+ GB of data over ethernet wire! If you don't have a network, get yourself an external disk of that size to get that done. The second problem with this feature is that it has a strict set of OS support. For example, it supports Ubuntu 11.04 but when we tried to pack the system running Ubuntu 11.10, it complained with a message indicating its impotency to convert the running OS into a bootable virtual hard disk. Still, if you're interested in this feature, Parallels might just be for you.

Exporting and importing virtual machines

While we've talked quite a bit about various virtual hard disk formats and cross-compatibility of one format with different virtualization software, there's in fact a general standard of exporting and importing virtual machines. It's called the Open Virtualization Format (OVF) or Open Virtualization Appliance (OVA). You can use both, VMware Workstation and VirtualBox to export to and import virtual machines using these standard formats.

UTILIZING YOUR DESKTOP FOR MORE

Secure yourself against viruses, port an environment and learn cross-platform development among other things

B y now, you must be impressed with virtualization and its ability to help you do so much. If you're not using it or aren't convinced about using it yet, this chapter is an attempt to lure you. If you're using it, here are a few good things you can do with virtualization. You'll slowly discover so much more to do with virtual machines than we're about to tell you about. Though it would surely depend on what you're

interested in doing with a virtual machine, here are a few good tips for you make virtual machines more useful and scenarios in which they can help!

Testing new operating systems

Windows 8 is all over the internet and enthusiasts have already begun experimenting with the OS. You might just be one of the many who're thinking of trying it out in beta to check out its features even before it's live on the desktop. Placing all excitement aside, there's the risk of the beta version not being stable enough, or your favorite/required applications not working. Also, setting it up as a parallel OS might be a risk if something goes wrong and you happen to lose all the important work, the whole software and multimedia collection on your system. Additionally, Windows is known to overwrite the boot loaders when you install the new version and then removal of the newer version becomes the difficulty. That's one of those reasons which keep most people from trying out the beta releases.

It's very obvious that virtualization is the solution to all that. If you want to test out a new operating system to check out the features or do some work, just install it as a virtual machine. If you like it, you can install it as the real operating system later. For the Linux distro-hoppers, who are a lot into trying out new Linux distributions, this is the perfect solution. If you want to know what great looks does the new Linux distribution have or what are the new features, run the OS as a virtual machine! Trying out new kernel or file systems was never so easy. If you want to see for yourself the new graphics effects Gnome 3 brings to you, VMware Workstation will not let you down! VirtualBox is not bad either – don't forget to enable the 3D acceleration, though!

There's one thing to remember when trying out operating systems and this is perhaps the third time we're saying this, but we must repeat – don't use virtual machines to test your hardware compatibility – virtualization is all about faking the hardware to the OS. You being able to run an OS in a virtual machine doesn't give any guarantee at all for it running smoothly on your real system.

Testing new software without slowing down your system

If you've been a creative professional who designs visuals using Adobe Photoshop and have been waiting since a year for the new release of your favorite software package because it would contain a feature you wanted badly, you'd know the value of virtualization.

At times when you really want to try out new software but can't do so for some reason – you already have a licensed older version working correctly or because you fear that installing too much at a time will slow down your system pathetically in the long run or because when the installer of the new version detects that you have an older version – it doesn't leave you with a choice except an upgrade. This is when virtual machines come to the rescue.

You can simply install a virtual machine and install your desired OS and software inside it. Try it, look for the features and if you're satisfied, you can install it. It's especially useful if the software you're trying to test out is a paid one. Virtual machines can help decide whether you really want it or not. Oh, and a virtual machine would have no problem if you tried and tested free software either!

Keeping yourself secure – virus checks and secure browsing

There are times when you want to check for viruses using multiple anti-virus tools. While some people are fond of installing more than one anti-virus with the rationale that "having two tablets for the headache is better than having one" without understanding the repecussions, at times you might just find yourself in need of using more than one anti-virus packages for scanning a file. Want an example? Here's one: let's say you downloaded new software from the internet and just before you install it, you see a review saying "Norton Anti-virus said it has a virus". But let's suppose you're using Avast which doesn't warn you about any such virus. That's FUD (Fear Uncertainty and Doubt)! That's one scenario when you'd want to have more than one anti-virus tool at hand. Now, there's a possibility that you might think you could simply install both anti-virus tools for once, scan the file in both and then remove the one which isn't needed. If you're one of those who agree with such ways of thinking, you may be surprised to know that two anti-virus products installed together are one of those perfect ways to slow down your system in the long term. Even if it's done for temporary use. This happens because during installations, installation programs usually don't clear some files from the disk and the registry keys they were created!

In addition, if you take the example above where we mentioned Avast, you might not be able to use both of them. When Avast detects that another anti-virus product is installed on your system, it will switch off all its components which might create a conflict with the other one. We're calling this a great feature because it ensures that if the user doesn't know about the

downsides of having more than one anti-virus tool on his computer, the product itself does its best to ensure the stability of the system. But then, think about it again – you have two anti-virus products installed on the system and you can use only one! That's how it should be but it doesn't fulfill your temporary need to install two anti-virus products at once!

We ask you – what's easier – installing a virtual machine and using it to run another anti-virus tool or installing two anti-virus tools on your computer and risking your OS installation? you're probably convinced at this stage of the usefulness of virtual machines for this purpose.

Virtual machines can also be used to do "secure browsing". With NAT featured by most virtualization software, you can access your host operating system's internet connection in the guest and use it for browsing the internet. In case you get a viral infection from the internet (because of a download or because you visited a malicious web site), it's just your "virtual" machine getting effected; reinstall it, or revert back to an older snapshot. This way you make sure that your host OS is not at any risk! Also, your browsing history, bookmarks and cookies and all such browsing activities is well protected with the guest operating system's authentication methods and if you still feel insecure, you can use encryption inside the virtual machine or encrypt the virtual machine itself (e.g. using the VMware Workstation's encryption feature). Yes, the virtual machine will take time to boot up and there's a little bit of an extra overhead but it's a perfect way to stay secure if you have something to lose.

Portability of an environment

At times when you need to set up an environment on more than one PC, virtualization is bliss. Someone might say that "hard disk cloning" is another solution. Yes, "hard disk cloning" indeed is a solution but when the hardware differs, it may not give you results you wanted. Think of a time when your friend asks you to set up a complex application development environment (LAMP is one of those environments), just the way you have it on your computer. There are a few things you can do:

▶ You can ask him to come to your home with a laptop and try to install it on his machine.
▶ You can go to his home to help him install the software.
▶ You can help him over the phone / email or chat, even remote control. But think about this:
▶ What if your friend doesn't have an internet connection?

▶ What if, during the process of installation, you upgraded something and that made the situation worse?

▶ In case you're guiding a person, instructing him remotely and he doesn't understand half the things are talking about, it is going to be confusing and frustrating as well!

The solution is – simply setup a virtual machine and hand it over to your friend! This way, you save time as well as a lot of headache which comes with helping a person remotely. Also, you need not be in his home for the night sitting in front of his PC; it can be done on your computer. There is no problem if he doesn't have an internet connection either – you simply have to install the software on your computer and then hand him over the files along with the setup file of your virtualization software. You don't have to risk breaking his current installation either.

See? Virtualization is bliss here, isn't it? It solves too many problems and rather complex ones in a simple go. There are simply a lot of ways virtualization helps you help others.

It is also useful for people who like to have their working environment with them. Obviously laptops are a solution but there are times when you just want to enjoy the feel of a PC. It might also be possible that you have two desktop PCs but no laptop! In such cases, just install the same virtualization software on both the computers and install a virtual machine and all the required software inside it. Now you can copy the virtual machine's installation directory in an external hard disk and you have the working environment wherever you go and there is no need to carry a big laptop when all that's needed is a small hard disk! In many ways, you're simply carrying your work environment with you and easily. The only trouble is to have the virtualization software on the end PCs. It's great for the nomad types. Note that virtual machines don't perform well over USB pen drives. So you can use a USB pen drive for copying the virtual machine's files but running a virtual machine straight through a USB pen drive would give you a bad performance hit. We would not recommend that you use USB pen drives for running virtual machines directly from them unless you don't have other options.

Legacy Applications – in Legacy Operating Systems

Are you still addicted to words like NFS2SE, MARIO or MS Word 97? Well, they don't work on Windows 7, do they? What about a really old accounting application? That won't work either. Still, men are made of habits and habits don't change easily - that includes our addiction to old applications. At times

using a legacy application is a need – such as an accounting application, which can work on a Windows 98 and probably on a Windows XP machine but not on Windows Vista or 7, and at other times it would just bring back the "good old days" feeling – the little old games we mentioned. Doesn't matter what it is you need your legacy applications for, virtualization is the way to go. That's because there's no way you'd be able to install Windows 98 on a modern computer for it can't run on multi-core platforms, or 64 bit or SATA disks or a large screen! Virtualization is the charmer if you're in need of legacy applications and a legacy OS.

If you have a powerful enough computer and VMware Workstation, you might just enjoy the old games we mentioned! VirtualBox should too do fine. Just remember to switch on the 2D and 3D acceleration!

A mini network setup

This one is for those inquisitive minds who keep trying new things. Though you can be an expert of your desktop computer and you don't need virtualization for anything we mentioned till now in this chapter, networking is something you can't do without having more than a single computer. If you're one of those who have a taste for networking, love running port scans, using netcat and packet sniffers, analyzing the traffic, trying out techniques to protect your computer and have the zeal inside you to learn the art but don't have more than one computer – you have the solution here!

Use the virtualization software of your choice to create more than a single virtual machine, install the desired operating systems in them, the required software and you're more than ready to go. You have two computers and a network connecting them. Your guest operating systems are never going to know you fooled them!

Now, we can't guide you to setup the network in detail and the problems you might face will differ from one virtualization software to another as well as across their different versions. We would however tell you that you need to set up an "internal network" for your virtual machines which you're going to use for the networking purpose. VMware comes with a "virtual network manager" which will help you with that. If you're using Qemu/KVM, the process is going to be a little difficult and here are two links to help you with networking part: *http://wiki.qemu.org/Documentation/Networking* and *http://en.wikibooks.org/wiki/QEMU/Networking* read them and you should be able to proceed a little further; do refer to man pages as well – they have a lot of info you want to have a look at!

Internal networking is a great way to learn about various networking techniques and methods. Of course if you don't have hell lot of memory (RAM) installed, you can't run too many machines in one go. Also, virtual machines are not going to emulate routers, hubs, switches and firewalls for you; nothing configurable to a decent extent at all! For learning about them, it would be great to get yourself some network emulation software.

If you're a security enthusiast and wanted to try out and learn about how to protect machines from attacks, virtualization is the way to go. You would not be breaking laws (we would not recommend or want our readers to fall into problems) and it is all safe with the data because you're just working with "virtual" systems. With snapshots put to use creatively, you can use virtual machines in quite a lot of useful manners to learn about networking from the operating system scenario. As such, virtual machines provide you an excellent platform for network security auditing of single machines.

Cross platform development

Save web development, almost every type of software development needs some cross platform testing. Even if you're simply coding an application which uses *the .NET* framework and runs on Windows XP, Windows Vista and Windows 7, you might just want to see that it runs fine on all three. In such a scene, you're in need of three operating systems and every single time you need to change something in the program code and test whether the change doesn't break the working in the different operating systems, you need to either reboot the computer (in case all the operating systems are installed on one single machine) or switch between the machines (if you installed the operating systems on three different computers). You either need to have three machines and a lot of space or you need to have a lot of time and patience to keep rebooting your machine! The situation gets more complex if you're developing something more cross platform which works on all supported versions of Windows and Mac as well as Linux. More operating systems and versions you try to support, more the headache you're calling for.

Let's stick only with *the .NET* development scene we discussed and compare that to virtualization – you can have three operating systems running at the same time as virtual machines. Keep your work on one and use the internal networking to make sure that your code is available on all the three virtual machines. Neither are you going to need a lot of time to keep rebooting the machine, nor are you going to be in need of three machines. All you need
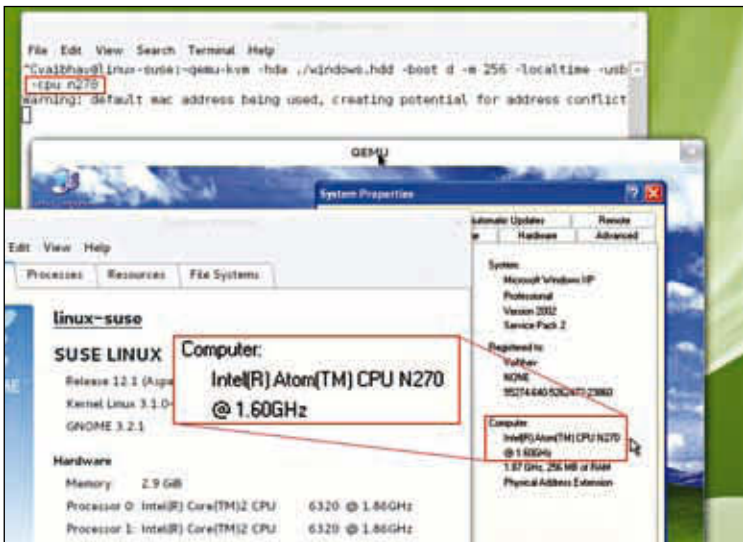
is a little bit more of RAM installed on your system – and that's going to be cheaper than three machines! We're sure you can see the difference!

Emulating another hardware platform

We said earlier that Qemu is a processor emulator. We also said that it won't give you really great performance. But wait! Qemu is exactly what you want if you want to emulate a CPU that you don't have. When you install Qemu (or Qemu/KVM), you get a whole lot of programs which are a part of Qemu package and run independently, just like Qemu. You can use those programs to emulate a CPU that you don't actually have. For example, if you have a 32-bit PC and you want to emulate a 64-bit one! Run the following at the terminal and you'll find that Qemu actually allows you to emulate other CPUs as well:

```
qemu-kvm -cpu ?
```

You're going to get quite an impressive list of various editions of x86 architecture families to emulate. Right from the 486 and Pentium 2 to Core duo and Phenom is available. Qemu emulates the AMD processors as well. You can use any of the mentioned processor architectures (the ones on the right within square brackets in the output) with the -cpu flag and Qemu will emulate it.

Qemu Emulating the Atom N270 processor on a Intel Core2Duo E6320 processor

qemu-system-x86_64 emulating 64-bit processor on a 32-bit Linux kernel. Note the "lm" in the list of CPU flags shown by a Backtrack Linux guest

If you installed Windows the way it was demonstrated in the workshop in a previous chapter, try running the installed Windows XP with -cpu n270 added to the end of the command to launch Qemu. Now after the machine starts up, click on the start menu and right-click the "My Computer" entry, then select the "Properties" option. In the general tab of the computer properties window, notice the processor name mentioned in the "Computer" section. You'll find that Windows thinks it's running on an "Atom N270" processor. That's Qemu combined with the command line power of Linux which your Linux friend might be boasting about!

However the output of the qemu-kvm -cpu ? command is going to differ from the output of the command: qemu -cpu ? . This is because KVM support is not available for all the processor types that Qemu can emulate.

Qemu can emulate architectures other than x86 (Intel) architecture family and quite a lot of them. This would include MIPS, SPARC, ARM and a few others. There's a separate program (binary executable file) for emulating each of those architectures. Just type qemu-system- on the command line and press the [Tab] twice. You'll get the list of those programs which can actually emulate the different architectures. The command line parameters that you can pass to those programs are going to be different than qemu or qemu-kvm and you need to figure them out with the main pages.
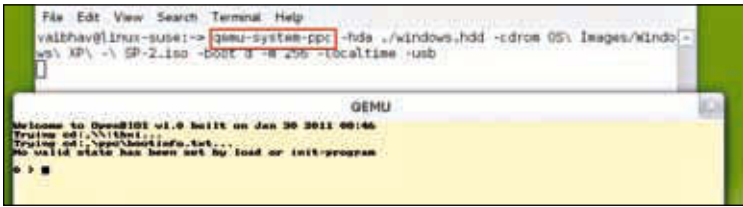
qemu_system_ppc showing error when trying to boot a Windows XP installation media on a PPC emulated processor

Since you may not be having an OS which runs on an architecture different than Intel, we'll try to run a 64 OS on a 32-bit machine, as we mentioned sometime ago. Use qemu-system-x86_64 in place of qemu-kvm in the command you would use to start your Qemu guest and you would be emulating a 64-bit CPU! If you're emulating an Intel 64 bit CPU and have a Linux guest in Qemu, go to the terminal / shell in the guest and type the command `cat /proc/cpuinfo`. In the output you get, you'll have a "flags" section. If you find the single word "lm" (don't consider "lahf_lm") there, then your CPU is 64-bit capable (this will work on 32-bit Linux kernel as well). Impressive, ain't?

Qemy can do lots more. It can also make individual programs written for different architectures run on your CPU by emulating the target CPU. There's quite a list of those programs available when you install Qemu, and all those "qemu-system-" architectures are supported. To find the list, type `qemu-` at the command line and hit [Tab] key twice. The output would include the "qemu-system-" ones as well so ignore them and you still have an impressive list. Now, you can go explore the options you can use with those programs and ways in which to use them.

If you're now considering Qemu as an option, that's great. It can save you the pain of having to search and find a machine with the right CPU that you're trying to target. It also helps you save up on cash that you'd normally spend on buying different types of machine with different architectures. Install Qemu and you'll find yourself at peace.

Hiding reality, fullscreen

This is a trick you can play with friends. You can simply install a virtual machine and then install the guest add-ons and turn on the fullscreen mode with auto-resize capability. Your screen would look as if you're actually using your guest operating system on your computer as the host!

From reality to dream

Among the various virtualisation software mentioned in this Fast Track, we spoke briefly about the Parallels Workstation and its unique ability of taking your current live system and packing it up as a virtual hard disk in the Parallel's native format so that it will work with the Parallels Workstation (and other products from the company). This can be immensely useful for making sure that whatever you have on your system is available to you in a portable format. It also helps you to take your system and convert it to a virtual machine which your friend might need (porting an environment). However, that feature doesn't work on every OS and takes up so much space on an external drive (if that's the method you choose) or time when transferring over the network. This isn't what you'll want to do very often but it can be a life-saver at times. If you're a Linux enthusiast, this method is similar to using the `dd` command to map up your whole hard disk into a removable media while running a live system. You could also pipe the output through a compression program to make the size smaller. **d**

VIRTUAL MACHINES ARE NOT THE SOLUTION TO EVERYTHING

VMs are useful for plenty of tasks, but these are definitely not them...

V irtualization is great and solves a lot of problems. However, there are limitations and scenarios where it can't be of any help and then there are times when virtualization itself is a problem. Though you won't run into too many troubles if you're a regular virtualization user, with knowledge comes power. Here are some of the scenarios where you can't or rather shouldn't use virtualization.

Low memory (RAM)

Virtualization means running multiple operating systems. If you have a system with insufficient memory installed, you might as well forget about virtualization. For example, if you have 1GB RAM and are running Windows 7, even with software like VirtualBox which is easy on resources, you won't be in a position to allocate any more than 256MB RAM for your VMs. So you can run Windows XP as a guest but there's no way you can try "Vista".

RAM is the first and the foremost requirement of virtualization. Without it, you're in no fair position to run virtual machines. Having less RAM and trying to use it to the maximum extent possible for virtualization makes the system prone to crashes. While testing a Ubuntu guest operating system with a Windows 7 host which has 1GB RAM while allocating 512 MB to the Ubuntu virtual machine on VirtualBox, the virtual machine crashed (it simply aborted) bringing down with it Google Chrome that was running on the host system. On another machine with the same amount of RAM, VMware Workstation as virtualization software and Windows 7 as the guest OS with 512 MB of virtual RAM and openSUSE as the host OS (running with firefox and LibreOffice Writer), the system almost froze and we had to switch to the command line to kill the VMware Workstation processes. In short, virtualization is not for computers with less memory. You can try it, but you can't expect high performance. You *can* expect your whole system to hang.

Apple's dramas

Mac runs on Apple hardware, only so if you're in all moods to test out a Mac OS X, we wish you best of luck. Though, our wishes aren't going to make Mac OS X run smoothly on a virtual hardware. Yes, you might just be able to run it, but the experience of the Mac OS X lies in its ability to make use of the great hardware features in Mac computers. There are tutorials and help all over the internet for all types of virtualization software to make them able enough to emulate Apple hardware correctly but you might just be getting into unnecessary trouble without results. Virtualization can't get a Mac OS X running, not easily at least! Apples and VMs don't mix well.

Gaming

Just because we mentioned NFS2SE and Mario doesn't mean they're definitely going to run. The ability to process graphics for gaming is an intense task and one with a high demand of parallelism. Virtualization is based on

emulation and as a matter of fact, emulation is slow. VMware Workstation is one product which tries to utilise your graphics hardware to a large extent for availing better 3D support on your guest operating system but still, graphics are not going to be great. In addition to this, the memory utilised by the virtual machine is also in control of the virtualization software and gaming as such is also hard on memory modules. While you might be able to run a few small games (we found *Age of Empires* – 2 ran well enough, because it's mostly 2D-based) and a few applications which demand 3D, it's going to need a really powerful system and you can't expect good performance.

Fancy effects

Windows has AERO and Linux has compiz for visual effects and both of them are not going to go well with virtual machines. VMware Workstation can make a Windows Vista or Windows 7 guest go with the AERO interface and Gnome 3 worked as well but don't expect them to run smoothly or be enjoyable. With any other virtualization software, you're down to basic effects only. Transparent Windows, translucent and blurred dashboards and all those compiz effects are great but they don't belong to virtual worlds. They need the touch of reality for them to work.

Testing your hardware for an OS

The only right information you're going to provide to your virtual machine inside a VMware Workstation or VirtualBox is the name of the processor. With VirtualBox, you can put the cap on execution and with Qemu you can fake everything altogether. Think about all of them at once and you might just start feeling like all the virtualization software – VirtualBox, VMware workstation and Qemu are quite the deceivers. Yes, they are indeed. That's their job and what they were "born" to do – lying to an operating system about the hardware. There's no way you can use the word "compatibility" with the words "hardware" and "virtualization" in a single sentence expect in this one. Never think about testing out hardware compatibility of an OS using virtual machines.

When you don't know what you're doing

This is one thing which can ruin everything – a user who is unaware of his or her actions. There are chances that you could use a great tool like virtualization as a weapon to shoot yourself. There are a few times when it can all go wrong. Here are a few of those times:

▶ **Using a partition as a virtual disk:** Both VMware Workstation and Qemu can be used to treat a real partition as a virtual hard disk. This will improve your PC's performance. But what if you just tried using another partition as a virtual disk where you already had an operating system installed? On Linux, typing in the wrong device filename can cause a disaster. These are mistakes you can't undo; not everything related to virtualization comes with a snapshot button. Don't try anything like this if you're not aware of what partitions are, how they're laid out and how an operating system makes use of them. You're calling for big trouble if you're the adventurous sort and have no idea of where you're going.

▶ **Trying cloning:** Many might tell you what we already did – you can actually use the dd command in Linux to make an image of your hard disk and later use it as a VM inside Qemu. Be careful, however; as you'll explore, you'll find that dd can display reckless behavior. It doesn't care from where it's reading and to where it's writing. If you just make a mistake with pressing the keys "I" and "O" on your keyboard and accidentally type in the "if" argument as "of" and the "of" argument as "if" to the dd command, you would have destroyed your hard disk easily and the disaster won't take more than a microsecond after you've pressed enter. Unless you know what you're doing or are ready to be responsible for the havoc and face the consequences, don't go ahead; ask someone who you think might know. Better still, trust Wikipedia and official sources for details.

▶ **Deleting your real files inside a VM:** This mistake can be easily committed by even those who're habituated to virtual machines. When you have a shared folder mounted inside the virtual machine, you might forget for a moment that those are real files on your system and try to delete them from within the virtual machine to make more room! This could often happen when the virtual hard disk is filling up. Always take care of how much free space is left inside a virtual machine. If it's getting low, add another virtual hard disk to it.

Despite a few pitfalls, virtualization is the bomb. We hope you're convinced as well as alert enough to try out a virtual machine. We have the software on the DVDs.